

1785

.1163

No. 56

No. *D785. U63*

No. 56



GIVEN BY

U. S. SUPT. OF DOCUMENTS

THE UNITED STATES
STRATEGIC BOMBING SURVEY

EFFECTS OF AIR ATTACK
ON
URBAN COMPLEX
TOKYO-KAWASAKI-YOKOHAMA

Urban Areas Division

June 1947

THE UNITED STATES
STRATEGIC BOMBING SURVEY

EFFECTS OF AIR ATTACK
ON
URBAN COMPLEX
TOKYO-KAWASAKI-YOKOHAMA

Urban Areas Division

June 1947



*D785

.U63

no.56

U. S. SUPERINTENDENT OF DOCUMENTS

JUL 19 1947

a.f.

This report was written primarily for the use of the U. S. Strategic Bombing Survey in the preparation of further reports of a more comprehensive nature. Any conclusions or opinions expressed in this report must be considered as limited to the specific material covered and as subject to further interpretation in the light of further studies conducted by the Survey.

FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from the late President Roosevelt. Its mission was to conduct an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating the importance and potentialities of air power as an instrument of military strategy for planning the future development of the United States armed forces and for determining future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the Survey in Germany have been published.

On 15 August 1945, President Truman requested that the Survey conduct a similar study of the effects of all types of air attack in the war against Japan, submitting reports in duplicate to the Secretary of War and to the Secretary of the Navy. The officers of the Survey during its Japanese phase were:

Franklin D'Olier, *Chairman*,

Paul H. Nitze, Henry C. Alexander, *Vice Chairmen*,

Harry L. Bowman,

J. Kenneth Galbraith,

Rensis Likert,

Frank A. McNamee, Jr.,

Fred Searls, Jr.,

Monroe E. Spaght,

Dr. Lewis R. Thompson,

Theodore P. Wright, *Directors*,

Walter Wilds, *Secretary*.

The Survey's complement provided for 300 civilians, 350 officers, and 500 enlisted men. The

military segment of the organization was drawn from the Army to the extent of 60 percent, and from the Navy to the extent of 40 percent. Both the Army and the Navy gave the Survey all possible assistance in furnishing men, supplies, transport, and information. The Survey operated from headquarters established in Tokyo early in September 1945, with subheadquarters in Nagoya, Osaka, Hiroshima, and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Pacific, and the Asiatic mainland.

It was possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement, and campaign by campaign, and to secure reasonably accurate statistics on Japan's economy and war production, plant by plant, and industry by industry. In addition, studies were conducted on Japan's over-all strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization, and the effects of atomic bombs. Separate reports will be issued covering each phase of the study.

The Survey interrogated more than 700 Japanese military, government, and industrial officials. It also recovered and translated many documents which not only have been useful to the Survey, but also will furnish data valuable for other studies. Arrangements have been made to turn over the Survey's files to the Central Intelligence Group, through which they will be available for further examination and distribution.

TABLE OF CONTENTS

	Page
Summary and Conclusions	1
The Target Area	3
Air Attacks	6
Economic Effects of Air Attacks	9
Industrial Production	18
Effects of Bombing on Industrial Tokyo	26
Table 1. Population and Density	3
2. Number and Type of Buildings	4
3. Extent and Distribution of Built-up Areas	4
4. Monthly Tonnage of Bombs Dropped in Area Raids	6
5. Monthly Tonnage of Bombs Dropped in Precision Attacks	6
6. Physical Damage Caused by Air Raids	7
7. Weight and Results of Major Area Raids	7
8. Air Raid Casualties	8
9. Comparative Effects of Bombing	8
10. Monthly Pre-Raid Average of Water-Borne Commodities	10
11. Monthly Average of Truck-Borne Commodities	11
12. Coal Consumption	12
13. Coke Consumption	13
14. Charcoal Consumption	13
15. Electric Power Consumption	14
16. Gas Consumption	15
17. Industrial Labor Force	16
18. Labor Efficiency	16
19. Decline in Industrial Factors	17
20. Decline in Industrial Factors During Raids	21
21. Comparison of Declines in Industrial Groups	21
22. Decline in Industrial Ratios	22
23. Decline in Production Factors—Damaged and Undamaged Plants	22
24. Number of Plants and Workers Prior to Raids	26
25. Decrease in Number of Plants and Workers During Raids	27
26. Decline in Workers During Raid Period	27
27. Decline in Production Factors, by Industry	29
28. Comparative Decline in Production Factors, by Industry	29
29. Decline in Production Ratios, by Industry	29
30. Decline in Production Factors, by Labor Group	30
31. Comparative Decline in Production Factors, by Labor Group	30
32. Decline in Production Ratios, by Labor Group	31
33. Workshops Destroyed in Air Attacks	32
34. Decline in Production Factors, by Damaged and Undamaged Plants	32
35. Comparative Decline in Production Ratios, Damaged and Undamaged Plants (Monthly Figures Covering Period October 1943 to August 1945)	32
Graph 1. Shipping—Gross Registered Tonnage, Tokyo-Yokohama-Kawasaki	34
2. Shipping—Total In and Out, Tokyo-Yokohama-Kawasaki	34
3. Average Daily Carloadings, Tokyo Division, Japanese Government Railway	35
4. Trucking—Total In and Out, Tokyo-Yokohama-Kawasaki	35
5. Coal Consumption, Tokyo-Yokohama-Kawasaki	36
6. Coke Consumption, Tokyo-Yokohama-Kawasaki	36
7. Charcoal Consumption, Tokyo-Yokohama-Kawasaki	37
8. Electric Power Consumption, Tokyo-Yokohama-Kawasaki	37
9. Gas Consumption, Tokyo-Yokohama-Kawasaki	38
10. Industrial Labor and Productive Hours, Tokyo-Yokohama-Kawasaki	38
11. Production, Tokyo-Yokohama-Kawasaki	39
12. Total Plant Sample, Tokyo-Yokohama-Kawasaki	39
13. Total Hit Plants, Tokyo-Yokohama-Kawasaki	40
14. Total Unhit Plants, Tokyo-Yokohama-Kawasaki	40
14-A. Production, Tokyo-Yokohama-Kawasaki	41
14-B. Electric Power Consumption, Tokyo-Yokohama-Kawasaki	42

	Page
14-C. Labor Force, Tokyo-Yokohama-Kawasaki	43
15. Aircraft, Tokyo-Yokohama-Kawasaki	44
16. Ordnance, Tokyo-Yokohama-Kawasaki	44
17. Shipbuilding and Repair, Tokyo-Yokohama-Kawasaki	45
18. Motor Vehicles, Tokyo-Yokohama-Kawasaki	45
19. Electrical Products, Tokyo-Yokohama-Kawasaki	46
20. Machinery and Tools, Tokyo-Yokohama-Kawasaki	46
21. Metal Products, Tokyo-Yokohama-Kawasaki	47
22. Basic Metals, Tokyo-Yokohama-Kawasaki	47
23. Chemicals, Tokyo-Yokohama-Kawasaki	48
24. Petroleum, Tokyo-Yokohama-Kawasaki	48
25. Miscellaneous Industries, Tokyo-Yokohama-Kawasaki	49
26. Public Utilities, Tokyo-Yokohama-Kawasaki	49
27. Total Plant Sample, Tokyo	50
28. Aircraft, Tokyo	50
29. Ordnance, Tokyo	51
30. Shipbuilding, Tokyo	51
31. Motor Vehicles, Tokyo	52
32. Electric Equipment, Tokyo	52
33. Machine and Tools, Tokyo	53
34. Metal Products, Tokyo	53
35. Tokyo Basic Metals Production	54
36. Tokyo Chemicals	54
37. Tokyo Miscellaneous	55
38. Tokyo Hit Plants	55
39. Tokyo Unhit Plants	56
(Bomb Damage Plots)	
Map A. City of Tokyo	Facing Page 56
B. Kawasaki, Japan, Bomb and Fire Damage	57
C. City of Yokohama	Facing Page 58

SUMMARY AND CONCLUSIONS

The Area Prior to Air Attacks. By the time the air attack was seriously undertaken against the Japanese home islands, in November 1944, Japan had been conducting military campaigns in China for seven years, and the Pacific phase of World War II had been under way for three years. The far-flung activities of its army and navy had drained the resources of the nation, the tightening Allied blockade and the submarine menace had reduced its sea-borne traffic, and its inept policy in allocating men and materials at home had placed a further strain on the already disintegrating economy. The great port city of Yokohama, which had long handled a quarter of Japan's foreign trade and ranked second in importance among the shipping centers of the Empire, was almost at a standstill, and its shipyards were given over to the repair of the few ships that could still put into its harbor. The enormous industrial concentration of Kawasaki was rapidly consuming its diminishing supply of raw materials in a final spurt of forced production; and the vast assembly plants of Tokyo were suffering a critical lack of component parts, which could no longer be turned out in sufficient quantities to meet the demands of the war machine. Although electric power was still abundant, the supply of coal had long been critically short, and consumption of its by-products, coke and gas, was drastically curtailed. While a sufficient number of workers was at all times available to industry, the efficiency of the labor force had been greatly reduced because of the administration's inability to achieve an equitable distribution of manpower between military and civilian requirements; and the conscription of skilled workers for the armed forces had left a void that could not be adequately filled with untrained laborers, women and minors. Thus, despite the fact that industry by consuming its dwindling inventories, had attained a peak production during the last months of 1944, the decline had already set in before the first devastating incendiary raid, in March 1945, laid waste to almost 16 square miles of the most densely populated areas of Tokyo.

The Physical Effects of Air Attacks. Apart from a few sorties against aircraft plants on the outskirts of Tokyo between November 1944 and February 1945, which served chiefly to accelerate the dispersal program in that industry, and seve-

ral intensive precision attacks on the oil refineries of Kakasaki in July and August 1945, which came too late in the war to influence the over-all decline in the complex, the entire bombing program was carried out during three consecutive months in the spring of 1945. For all strategic purposes, the air attack in this area of Japan was over by the end of May. In this short period, over 18,000 tons of bombs were dropped on the three cities, out of a total of almost 23,000 tons delivered to the complex. Practically all of the physical damage and most of the casualties occurred during the seven area raids in these three months. Altogether, over 70 of the 142 square miles of built-up area were completely devastated, and almost 863,000 out of a total of 1,454,000 buildings were destroyed. Some 4.6 million of the 8 million inhabitants were evacuated, more than 3.4 million having lost their homes. The total number of killed amounted to nearly 100,000, and an equal number was injured. The physical effectiveness of the area raids is demonstrated by the fact that an average of 300 tons of bombs were dispatched from the Marianas to devastate 0.45 square mile, destroy 54 buildings and produce 6 casualties.

The Economical Effects of Air Attacks. If the mass incendiary raids against Japanese cities were intended to disrupt the economic life of the communities, destroy their industrial potential, and thereby weaken the will and the ability of the people to support the military operations of its leaders, these attacks may be said to have been highly successful. The industrial sample of the complex showed a loss in Yen production of 66 percent, the Tokyo sample 65 percent. These samples, however, contained only those plants employing over 100 workers, which in Tokyo accounted for about 50 percent of the total city product. Here it was found that production in plants employing under 100 workers, representing the remaining 50 percent of the total product, decreased approximately 75 percent. Therefore, if one-half of Tokyo's production declined 65 percent and the other half 75 percent, the total decline amounted to 70 percent, which closely approximated the drop of 74 percent shown by the over-all data for the complex in Table 19. The loss due to bomb damage in the larger plant category in Tokyo was found to be 32 percent out of a total decline of 65 percent; and almost all of the decline

in the smaller category was due to the same cause. Thus, if a 32 percent loss in one-half of the city's production and (conservatively) a 68 percent loss in the other half were due to bomb damage, the total loss from this cause was 50 percent out of a total decline of 70 percent. While Tokyo contained an unusually high proportion of small plants, as compared with the complex as a whole (whose sample of larger plants was found to have lost only 19 percent out of 66 percent as a result of bomb damage), it must be emphasized that the sample did not contain those plants which were completely destroyed, and whose inclusion would have increased the percentage of loss due to destruction. Therefore, it may be concluded that approximately half of the drop in production for the entire complex was the result of direct bomb damage to plants.

Conclusion. The Survey has estimated elsewhere that, even had there been no air attacks on the home islands of Japan, increasing shortages of raw materials would have depressed industrial activity by August 1945 to around 60 percent of its pre-raid level. However, as the Yen value of production in the Tokyo-Kawasaki-Yokohama complex had declined at least 70 percent, the difference between the Survey's estimate and the actual drop must reflect disturbances other than the shortages mentioned above. In view of the fact that the decline in production had already set in well before March 1945, it is quite possible that bomb damage merely had the effect of destroying surplus productive capacity, which in no way affected the rate of decline thereafter. If

this is true, it is equally valid to state that the shrinking stocks of raw materials also proved to be partially surplus during the same period, as the actual drop in production was eventually greater than the estimated loss due to shortages of such materials. Bomb damage alone, as we have seen, accounted for a loss equal to that which might have been induced by shortages, and both were exceeded by the actual decline. It may be said, then, that even had there been no direct bomb damage to plant and equipment and no shortage of raw materials, the ultimate decline would not have been radically changed. The same, however, cannot be said of the indirect effects of air attacks, for the destruction of homes, the injury or death of relatives and friends, the disruption of local transportation and other public services, all had produced a critical rise in absenteeism at the plants and lowered the efficiency of the remaining workers. Just how much of this undermining of public morale was the result of air attacks, and how much can be attributed to undernourishment, illness and fatigue, could not be determined precisely from the statistics collected; but it is evident from the individual reports of manufacturers that the incendiary raids on the complex played a decisive role. This fact, coupled with that of bomb damage to industrial plants, warrants the conclusion that, in the final analysis, the decline in production in most industries in this area after December 1944 was due primarily to the effects, both direct and indirect, of air attacks, and only secondarily to shortages of raw materials, fuel and, to some extent, skilled workers.

THE TARGET AREA

The Kanto Plain. One of the most highly industrialized and densely populated areas in the world lies in the lowlands of the Kanto Plain, on the eastern coast of the main Japanese island of Honshu. This plain, at the vertex of the angle formed by the island, covers an area of approximately 2,500 square miles, or 5 percent of the total area of the homeland, and contains almost 20 percent of Japan's population. Twenty-eight of the country's 182 chartered cities lie within this district, approximately 85 percent of the 12,000,000 inhabitants living within urban communities. Although some minerals are mined in the plain (particularly copper, at Hidachi in East Kanto), fabrication of finished products represents its main contribution to the country's economy. Most of the raw materials and semi-finished products converted in its factories are shipped in from abroad and from other sections of the Empire. Large quantities of rice are grown in the alluvial lowlands and some wheat and barley in the more arid uplands of the plain; but the valley is one of the least fertile of the country. Of the 13 percent of national food products contributed by the Kanto district in 1940, all but 1 percent was represented by the fish catch. In the same year, 25 percent of all Japanese industrial workers were employed in this area, a percentage which probably corresponds closely to that of its industrial production.

The Urban Complex. The industrial heart of the Kanto Plain is the urban complex of Tokyo, Kawasaki, and Yokohama, which forms a continuous built-up area extending 25 miles along the western shore of Tokyo Bay, on a parallel approximating that of Los Angeles, California, and Raleigh, N. C. (35° N). The three cities combined cover 429 square miles, with a normal population of 8 million, or 11 percent of the national total. Prior to the destruction caused by air attacks, over 30 percent of the above area was thickly settled, particularly along the water fronts. The congested wards of Tokyo, north and east of the Imperial Palace, contained numerous small and medium-sized workshops, while the larger industrial installations were situated on the outskirts of the city, and south along the bay into the harbor district of Kawasaki. The principal trading cen-

ters were east and south of the Palace, and occupied practically the whole of Yokohama. Shipping activities were conducted along the entire length of the bay shore, with the chief port facilities in Yokohama.

Population. In the twenty years between 1920 and 1940, the number of inhabitants in the three cities had doubled; and by the beginning of 1944, the complex was supporting 18,800 persons to the square mile, the more congested wards averaging 80,000 per square mile. The most densely populated area in the complex, Asakusa ward north-east of the Imperial Palace, had a density of 130,000. Table 1 shows the population of each city for four census years, together with the density based on the 1940 census:

TABLE 1.—Population and density

Year	Tokyo	Kawasaki	Yokohama	Total
1920 -----	3,358,597	85,133	579,310	4,023,040
1930 -----	4,986,913	148,447	704,236	5,839,596
1940 -----	6,778,804	300,777	968,091	8,047,672
1944 (February)	6,577,620	380,919	1,034,740	7,993,279
Area (square mile) -----	223	50	156	429
Density (per square mile) --	30,398	6,016	6,206	18,759

Source: National Census.
NOTE.—The population drop in the Tokyo figures for 1944 was due to planned evacuations prior to the period of air attacks on the capital.

Housing. After the disastrous earthquake of 1923, many modern fireproof buildings were constructed in the devastated areas of Tokyo. Kawasaki, and Yokohama, principally in the heavily damaged commercial sections of the cities. The remainder of the area, however, continued to house the majority of the population in the inflammable wooden structures prevalent throughout Japan. In early 1944, there were approximately seven persons per unit in the 1,135,800 residential buildings. Though dwellings represented 75 percent of all buildings, many so-called residences were used partially for small stores and workshops, while portions of many larger buildings, counted as industrial plants or commercial houses, were utilized as residences by the owners. Thus, the figures in Table 2 can be accepted only as approximate for the number and function of buildings existing at the time of the February 1944 census:

TABLE 2.—*Number and type of buildings*

City	Residential	Industrial	Other	Total
Tokyo-----	875,200	48,300	237,500	1,161,000
Kawasaki-----	60,500	1,600	6,800	68,900
Yokohama-----	200,100	2,300	21,500	223,900
Total-----	1,135,800	52,200	265,800	1,453,800

Source: National Census, 1944.

NOTE.—The figures for "Industrial" and "Other" categories in Kawasaki were estimated from the proportion of buildings in the other two cities, and from a comparison of building areas and number of industrial workers.

planned evacuations prior to the period of air attacks on the capital.

Land-use Zones. The built-up sections of the three cities constituted 33 percent of the area of the urban complex, and represented 35 percent of the total built-up area of the 66 Japanese cities subjected to area attacks. Table 3 shows the extent of built-up areas in the three cities, together with the areas actually covered by various types of buildings:

TABLE 3.—*Extent and distribution of built-up areas (square miles)*

Area	Tokyo	Kawa-saki	Yoko-hama	Total
Total urban area -----	223.0	50.0	156.0	429.0
Total built-up area -----	111.0	11.0	20.0	142.0
Percent of built-up area ---	50	22	13.0	33
Building areas:				
Residential -----	26.3	1.1	3.8	31.2
Industrial -----	5.8	.4	.7	6.9
Other -----	14.8	.7	2.4	17.9
Total building area --	46.9	2.2	6.9	56.0
Percent of building area to built-up area -----	42	20	35	39

Source: AAF Photo Interpretation; Japanese municipal statistics.

Importance of Urban Complex. The metropolitan area covered by Tokyo, Kawasaki, and Yokohama is one of the largest and most important in the world. Tokyo, the capital and largest city in the Japanese Empire, was surpassed in population only by New York and London. As the home of the Emperor, it was at once the center of Japanese culture and the source of all civil and military authority; but more significant still, it was the commercial and industrial heart of the Empire. Kawasaki, the ninth city of Japan, contained the greatest single concentration of industrial plants in the country, nearly all of them producing the materials of war; and because of its position between Tokyo and Yokohama, it was an essential link in the transportation system of the nation. Yokohama, the fifth city and second port of Japan, was of primary importance in Japanese

foreign trade and as a port of entry for the entire Kanto Plain. Though chiefly a trading center, it was also of vital importance in the production of war goods.

Land Transportation. The urban complex contained the most complete network of railroads in Japan, with five main government lines leading to all parts of the main island of Honshu, two of them passing through all three cities. Although Yokohama contained railway repair shops of some importance, and a few minor shops were located in Tokyo, the most extensive and complete repair facilities were to be found at Omiyo, 17 miles north of the capital. The large marshalling yards in the area handled a considerable portion of goods for transshipment to and from all parts of the Empire. Closely tied in with the rail transportation system were the five main highways of Japan, all of which radiated from Tokyo. The Tokaido Road, which traversed three-quarters of the length of Honshu, passed through all three cities of the complex, and was of extreme importance in the transportation of both civilian and war goods.

Shipping. The importance of the urban complex as a center of land transportation was exceeded by that of its shipping. Prior to the war, Yokohama alone handled about 25 percent of all Japanese foreign trade, and most of the waterborne goods to and from Tokyo were funnelled through this port. Its 25 mooring buoys could accommodate 16 ocean-going vessels of average size, and its passenger wharves could handle ships up to 50,000 tons. Yokohama contained the fourth largest shipbuilding yard in Japan, with extensive repair facilities. There were excellent docking facilities also at Kawasaki, though they were not so extensive as those in the other two cities. Tokyo had no natural deep water harbor, but dredging permitted the entry of ships up to 10,000 tons. Some 80 vessels up to 6,000 tons could be accommodated at one time, and the 3 large wharves handled a large part of the city's own shipping. Tokyo and Yokohama together had almost 80 miles of navigable rivers and canals, which could take barges and lighters up to 20 tons; and these inland waterways played an essential part in local transportation both before and during the war.

Public Utilities. During the year 1943, Tokyo, Kawasaki, and Yokohama accounted for 11 percent of the 29 billion kilowatt-hours of industrial

electric power consumed in Japan, 70 per cent of the local power being consumed in Tokyo. More than 80 percent of this electricity was supplied from hydroelectric plants in the highlands, the remainder being furnished by coal-powered stations throughout the urban areas. Steam power, which was used to some extent locally, was supplied by Kawasaki with this city alone accounting for more than 25 percent of all steam power produced in Japan. During the same year, the three cities consumed over 467 million cubic meters of gas, produced mainly by the large works in Yokohama and Kawasaki. The water supply, like the gas and electric systems, was an integrated network throughout the complex, Kawasaki being the prime producer.

Industrial Importance. It is estimated that during the war years Tokyo, Kawasaki, and Yokohama together accounted for about 20 percent of the total industrial output of Japan. The numerous home workshops existing throughout the area prior to 1940 had been greatly reduced and their owners and workers transferred to larger plants where their labor could be utilized more efficiently. In Tokyo alone, the total number of industrial plants of all sizes had decreased from 91,370 in 1940 to 41,548 in October 1944, while the number of workers had increased from 728,092 to 1,101,507 over the same period. At the time of the national census of February 1944, the three cities employed 1,542,735 workers, or 16 percent of the

industrial labor force of the nation. Less than a quarter of a million were engaged in trade at the same time. The principal products turned out of its factories and refineries were aircraft and aircraft engines, machinery and tools, iron and steel, munitions, chemicals, textiles, and oil. Tokyo was responsible for the greater portion of most of these products, though Kawasaki possessed the important oil refineries and a large share of the chemical plants. Yokohama's chief importance lay in its shipyards, although its industrial output was considerable.

Strategic Importance. The metropolitan area of Tokyo, Kawasaki, and Yokohama, with the largest city, the second largest port, the highest trade volume, and the greatest concentration of industrial plants in the country, was of the utmost strategic importance to Japan's wartime economy. As the seat of all authority, both civil and military, it was the administrative as well as the economic heart of the Japanese Empire. Its network of land and sea transportation, which carried the materials of war from its vital factories, added further to its prime significance in the Japanese economy. Any disturbance of its efficient operation was, therefore, bound to affect to a great degree the essential activities of the nation as a whole; and it was inevitable that this urban complex should become the first and main target in the air war against Japan.

AIR ATTACKS

Target Location. In the autumn of 1944, when air attacks were initiated against the Japanese home islands the first raids were launched from Guam, 1,500 miles away. Before Iwo Jima (600 miles) and Okinawa (840) could be used as air bases, Japan's largest cities had already suffered the heaviest attacks of the campaign. The urban complex of Tokyo, Kawasaki and Yokohama, located in the heart of the central island of Honshu, was the most vital and at the same time one of the most inaccessible of the city targets on the Allied bombing program.

History of Air Attacks. During the period from November 1944 to August 1945, the Twentieth AF conducted 11 major raids and innumerable lesser attacks and isolated sorties against the three cities with the overwhelming weight of bombs falling on Tokyo. The capital was the target for six of the eight major area raids, Kawasaki and Yokohama receiving one each. Of the three major precision attacks, one was directed against aircraft plants on the outskirts of Tokyo, the other two against oil refineries in Kawasaki. During the 10-month period of the air war, 4,230 planes delivered 22,885 tons of bombs to the area, representing 14 percent of the total tonnage (159,744 tons) dropped on the 66 Japanese cities subjected to area raids. Of the local tonnage, 16,217 tons, or 71 percent were incendiaries. Navy strikes were responsible for 144 tons, directed primarily against aircraft plants and shipping.

Area Raids. Area raids accounted for 79 percent of the tonnage dropped on the three cities. The most devastating attacks were carried out during March, April and May 1945. Eighty-nine percent of the total area raid tonnage was dropped in these 3 months. By far the most effective air attack against any Japanese city was the predawn incendiary raid on Tokyo on 10 March 1945, which resulted in a greater degree of death and destruction than that produced by any other single mission in any theater during World War II. The success of this raid was due partly to the surprise performance of the high-altitude B-29s operating at low levels (5,000 to 7,000 feet) in the first such attack of the war. Table 4 gives the tonnage of bombs dropped on the three cities during the area raids.

TABLE 4.—Monthly tonnage of bombs dropped in area raids

Month	Tokyo	Kawasaki	Yokohama	Total
November 1944	302	—	4	306
December	102	—	4	106
January 1945	205	—	3	208
February	859	8	14	881
March	2,060	3	—	2,063
April	3,031	1,504	3	4,538
May	6,976	7	2,570	9,553
June	—	—	—	—
July	10	—	—	10
August	386	32	—	418
Total	13,931	1,554	2,598	18,083

Source: Twentieth AF.

Precision Attacks. Attacks against limited targets and specific installations accounted for only 21 percent of the total bomb tonnage delivered to the three cities. The primary objectives were the aircraft and oil industries, with a few minor attacks directed against the steel and electrical equipment industries and shipping. The major attacks on the aircraft industry, carried out almost exclusively against the Nakajima installations on the outskirts of Tokyo, occurred in April 1945; while the greatest weight of bombs was dropped in this type of attack on the three large oil refineries in the harbor district of Kawasaki in July and August, just prior to the termination of the war. The remainder of the attacks were of minor importance. Table 5 gives the tonnage of bombs delivered to specific targets during the raid period:

TABLE 5.—Monthly tonnage of bombs dropped in precision attacks

Month	Targets					Total
	Aircraft	Oil	Steel	Electric Equipment	Shipping	
November 1944	112	—	—	—	—	112
December	247	12	3	—	—	262
January 1945	42	9	6	—	—	57
February	35	3	—	—	6	44
March	112	3	—	—	—	115
April	2,002	—	—	—	—	2,002
May	3	—	—	—	—	3
June	38	—	—	—	—	38
July	5	1,102	—	—	3	1,110
August	—	1,017	—	42	—	1,059
Total	2,596	2,146	9	42	9	4,802

Source: Twentieth AF; Naval Air Force.

Physical Damage. While precision attacks naturally caused considerable physical damage in limited areas, the greater part of it was produced on the periphery of Tokyo, whose outlying suburbs are not considered in this discussion, and on the harbor district of Kawasaki. The area raids may therefore be considered responsible for practically all of the physical damage produced in the three cities. The devastated sections of the urban complex covered 70 square miles, or slightly more than 49 percent of the built-up areas of the three cities. This destroyed area in turn represented 39 percent of the total devastation caused by bombing in the 66 cities subjected to area raids. Approximately 59 percent of all buildings in the urban complex were destroyed, and an additional 5 percent were damaged. The attack of 10 March alone was responsible for 23 percent of the devastated area and 9 percent of the building destruction. Harbor facilities were damaged in all cities and almost half of the warehouses along the water fronts were demolished. Damage to substations and transmission lines reduced the electric power capacity available in the area from approximately 2 million to 1.7 million kilowatt-amperes; and the destruction of gas plants cut production of this fuel to less than half the normal capacity. Table 6 shows the areas of devastation and the number of buildings destroyed in each city.

Distribution of Bomb Damage. The pattern of destruction in the area raids followed the most heavily built-up and densely populated districts along the water fronts of the three cities (Maps

TABLE 6.—Physical damage caused by air raids

Type of Damage	Tokyo	Kawasaki	Yokohama	Total
Built-up area (square miles)	111	11	20	142
Area destroyed	57	4	9	70
Percent of destruction	51	36	45	49
Number of buildings	1,161,000	68,900	223,900	1,453,800
Buildings destroyed	727,655	35,107	100,070	862,832
Percent destroyed	63	51	45	59

Source: Police officials, Tokyo, Kawasaki, Yokohama.

A, B and C). The greatest damage was inflicted in the congested ward of Asakusa, northeast of the Imperial Palace, in the raid of 10 March. The raid of 13 April destroyed sections north of the Palace, while that of 15 April struck the extreme southern shore line of Tokyo, with a spill-over into Yokohama. The attacks of 23 and 25 May, while devastating the greatest area, were less effective than the others, as they were centered in the thinly populated districts in the southwestern part of the capital. The raid of 15 April on Kawasaki laid waste the highly industrialized harbor area and spilled over into northern Yokohama; while the attack of 29 May on the latter city gutted the main business district along the water front. Of the 6.9 square miles occupied by industrial buildings in the urban complex, 1.9 square miles, or 28 percent were destroyed in the course of the air war. Table 7 gives the tonnage of bombs dropped and the extent of destruction in the three cities for each of the major area raids.

TABLE 7.—Weight and results of major area raids

Date of attack	Bomb tonnage			City	Area destroyed (sq. mi.)	Buildings destroyed
	HE	IB	Total			
1945						
25 Feb.-----	45	412	457	Tokyo-----	1.0	27,970
10 Mar.-----	--	1,667	1,667	do-----	15.8	256,010
13 Apr.-----	82	2,037	2,119	do-----	11.4	
15 Apr.-----	15	754	769	do-----	*7.5	217,130
15 Apr.-----	38	1,072	1,110	Kawasaki-----	3.6	31,603
23 May-----	--	3,646	3,646	Tokyo-----	3.2	
25 May-----	4	3,258	3,262	do-----	18.6	221,160
29 May-----	--	2,570	2,570	Yokohama-----	8.9	89,073
Total-----	184	15,416	15,600		70.0	842,946

Source: Twentieth AF; city police departments. *Including 1.5 square miles of Yokohama.

Casualties. According to Japanese estimates, the number of people left homeless as a result of the air attacks on the three cities reached 3.4 million, or 43 percent of the total population. Official Japanese estimates also place the number of persons evacuated from the urban area at around 4.6 million, or 58 percent of the population. The records of city police officials show that casualties in the area amounted to almost 199,000, or 40 percent of the casualties for Japan as a whole, approximately 60 percent of the local figure being the result of the one raid of 10 March 1945. The number of missing persons was never determined in this area. It is quite possible that many people otherwise unaccounted for should have been counted among the dead. In like manner, many of the severely injured probably died later of their wounds, while a considerable number of the slightly injured may never have been reported. In view of these possibilities, the figures in Table 8 should be considered as minimal.

TABLE 8.—*Air raid casualties*

Casualties	Tokyo	Kawasaki	Yokohama	Total
Population,				
February 1944_____	6,577,620	380,919	1,034,740	7,993,279
Killed_____	93,056	1,520	4,832	99,408
Injured_____	72,840	8,759	17,967	99,566
Dehoused_____	2,890,000	154,426	399,187	3,443,613
Percent dehoused_____	44	41	39	43
Evacuated_____	4,100,000	150,000	350,000	4,600,000
Percent evacuated_____	62	39	34	58
Population,				
August 1945_____	2,310,734	216,197	637,024	3,163,955
Percent decrease_____	65	43	38	60

Source: Ministry of the Interior; city police departments.

Air Raid Defense. In anticipation of air attacks, the Japanese organized a Civilian Defense Corps (Keibo Dan), which centered around the local police stations. It was composed of civilians charged primarily with the duties of fire fighting and evacuation. The Japanese Government further instructed the people through press and radio in air-raid precautions and urged them to construct their own shelters. This seems to have been the full extent of official aid in the protection of the populace against air attacks. The shelters constructed by individuals consisted mostly of shallow trenches covered with boards and dirt; only the larger factories were able and willing to provide adequate shelters for their own workers. With the advent of mass incendiary attacks, however, the entire defense system collapsed, and the

inadequate shelters proved to be more of a trap than a refuge.

Rehousing and Evacuation. The municipal authorities made ineffectual attempts to house the flood of air-raid victims, throwing open the temples and schools to the homeless. This was a mere emergency measure, however, providing shelter for a week or 10 days. The immense majority of the bombed-out population migrated to the surrounding country side. The government set up a system of compensation for completely destroyed buildings, amounting to 40 percent of their values, with an additional payment of 50 Yen per occupant to cover personal losses. Many of the people used the money to rebuild their homes, but the shortage of building materials rendered impossible any large scale program of reconstruction. By the end of the war, the population of the urban complex had been reduced to a little more than a third of its pre-raid figure. Tokyo alone lost almost two-thirds of its inhabitants.

The Impact of Area Raids. The program of mass incendiary attacks on the metropolitan complex of Tokyo, Kawasaki, and Yokohama, with its initial element of surprise, its devastation of congested areas, and its vast destruction of life and property, was bound to have a terrifying effect upon the people and to produce a complete if temporary paralysis of the economical life of the community. In its disruption of transportation and communications, its reduction of the output of industry and the efficiency of its workers, and its injection of confusion into the already ineffectual administrative machinery, the results of the air war against the most important of Japan's urban areas affected to a marked degree the morale and economic productivity of the entire nation. An indication of the importance of the damage inflicted is given in Table 9, which compares the local effects of bombing with those for Japan as a whole:

TABLE 9.—*Comparative effects of bombing*

Damage	All Japan	Urban complex	Percent
Area destroyed (square miles)_____	178	70	39
Buildings destroyed_____	2,236,159	862,832	39
Persons dehoused_____	8,735,079	3,443,613	39
Persons evacuated_____	*9,789,022	4,600,000	47
Killed_____	235,616	99,408	42
Injured_____	265,556	99,566	37

* This figure is only for the 66 cities subjected to area raids.

ECONOMIC EFFECTS OF AIR ATTACKS

Introduction. From the extent of physical damage described in the foregoing section it would seem that bombing must have had a tremendous direct effect on the economic activities of Tokyo, Kawasaki, and Yokohama. Physical damage, however, cannot be used as a measure of the total economic loss due to air attacks, for, while area raids, and to some extent precision attacks, did reduce the total industrial potential, remaining plant facilities were in general still adequate for the ever diminishing supply of fuel, raw materials, and component parts brought into the area. The shortages of these essentials were due not so much to air attacks as to effective sea blockade of Japan and the inadequacy of both water and land transportation at home and abroad.

Transportation. The network of highways, railroads and shipping lines that made up the transportation system of Japan was, by its very nature, susceptible to enemy action in all parts of the Empire, and reflected to a remarkable degree the economic ills of the nation. It was at once the agent and the barometer of fluctuations in industrial production and distribution and any disruption of its efficient operation in any part of the Empire was felt to a greater or lesser degree in the mining and manufacturing centers of the home island and in the economy of the country as a whole. Thus, an analysis of the transportation problems on a city level must take into account the factors, both normal and wartime, which affected the situation in other areas. This is particularly true of the Tokyo-Kawasaki-Yokohama complex, where the shortage of transportation facilities was caused primarily by forces operating far beyond the limits of the area itself.

Shipping. Owing to the peculiar problems of Japanese shipping during the last 2 years of the war, the fluctuations marking the movement of vessels in Tokyo Bay cannot be measured in terms of the direct and indirect effects of bombing on ships and port facilities locally. The generally critical situation throughout Japan, attributable to air and submarine attacks and the mining of channels, exercised a decisive influence on activities in the harbor. Enemy action reduced the inflow of iron and other metals from the south and coal from the north; and the shortage of bottoms, either lost at sea or tied up in other ports, created further difficulties in the export of finished goods

and component parts to other cities on the main islands and to the distant military outposts of the Empire. The movement of ships was at all times erratic, with the gross registered tonnage of vessels arriving in the harbor dropping from 18.8 million in 1942 to 7.8 million in 1943 and 3.6 million in 1944. The number of ships putting into port during the same years was 5,882, 3,205 and 2,075, respectively. Thus, long before the bombing program was initiated against the area, shipping had suffered a sharp decline.

Decline in Shipping during the Raid Period (Graph 1). During the period under survey, October 1943 to August 1945, a peak of 570,969 gross registered tons was reached in February 1944, the most precipitous drop occurring between May and August of that year. From the latter month until February 1945, gross registered tonnage arriving in the harbor fluctuated between 116,000 and 176,000 monthly, thereafter declining steadily to 25,000 tons in July. Incoming freight tonnage was much greater than that of outgoing, the monthly average during the preraid period being 168,070 tons and 112,772 tons, respectively. The trend in freight tonnage followed roughly that of gross registered tonnage of vessels in the harbor, divergences being attributable to the fact that ships often arrived with partial loads and departed in ballast. Though there was some damage done to warehouses and port facilities throughout the area during the period of air raids, attacks on the harbor district did not materially accentuate the fluctuations in sea-borne traffic.

Water-borne Commodities. Figures on freight shipments were obtainable only for the months of January 1944 through March 1945; and the commodity classifications even for this period are incomplete. However, as fluctuations in freight movements follow the general decline of gross registered tonnage during comparable periods, it may be assumed that the trends were similar to the end of the war (Graph 2). In the statistics available, a peak of 388,096 tons of incoming freight was reached in January 1944, with a high of 184,304 tons of outgoing freight occurring the following month. The decline in both categories was gradual, the low point of 46,049 incoming tons being registered in December 1944 and 53,787 outgoing tons in February 1945. The relative importance of the various commodities is seen in Table

10, which shows the average monthly shipments recorded during the preaid period, February 1944 through January 1945.

TABLE 10.—*Monthly preaid average of water-borne commodities*
[Metric tons]

Commodity	Incoming	Per- cent	Outgoing	Per- cent
Fuel-----	79,701	48	13,994	12
Metals and metal products-----	24,153	14	20,877	19
Building materials-----	6,554	4	9,801	9
Machinery-----	718	--	2,029	2
Food-----	3,711	2	250	
Others-----	53,225	32	65,722	58
Total-----	168,062	100	112,673	100

Sources: Maritime Bureau, Tokyo; harbor master, Yokohama.

Damage to Harbor Installations. Almost all of the destruction around Tokyo Bay occurred in April and May 1945, during the four heavy area raids on the three cities. Three docks, with a combined capacity of 10 vessels of 5,000 tons, were destroyed in Yokohama, leaving only the central pier intact. Of the 60 loading cranes in Tokyo, 31 were damaged and disruption of utilities in Yokohama temporarily prevented the operation of electric-powered cranes in that city. Of the 3,185 lighters operating in the harbors, with an average capacity of 100 tons each, 1,066 were destroyed. Warehouses covering 3,900,000 square feet were demolished, representing a loss of almost 45 percent of the 8,783,500 square feet of available space in the three cities; and 48,270 tons of stored goods, 33 percent of which were foodstuffs, were damaged in Tokyo alone. In the latter city, 304 dock laborers were killed and 5,857 injured, out of a total of 8,471. Dock labor in Kawasaki and Yokohama was reduced to 20 percent of normal; but as only about 10 percent of the normal cargo was handled after the raids, reduction in the labor force was not important. No attempt was made to repair or enlarge port facilities in any of the cities, as the undamaged installations were sufficient to conduct the diminished shipping operations. The extent of physical damage would appear at first glance to have been sufficient to disrupt activities in the ports, but the fact that remaining facilities were adequate for the reduced operations in the Bay nullified the damaging effects of the raids. There were no sudden drops in shipping coincident with air attacks; and it is therefore evident that the erratic fluctuations and

steady decline in the movement of water-borne freight were the results of wartime factors affecting transportation elsewhere.

Rail Transportation. The main islands of Japan were divided into railway divisions covering fairly large areas of the country; and very little data could be obtained for individual cities. The Tokyo division included the major portion of the Kanto Plain; but as the greater part of all rail activities in the area centered around the urban complex of Tokyo, Kawasaki, and Yokohama, figures for the division may be accepted as indicative of rail movements in the complex (Graph 3). The average monthly car loadings were 4,981 during the preaid period, February 1944 through January 1945. Up to the latter month, car loadings fluctuated between 4,700 and 5,300, the trend thereafter registering a steady decline, except for slight rises in March and May, to a low of 3,500 in June, the last month for which statistics are available. The fact that car loadings did not decrease more rapidly is due primarily to the necessity for shifting the burden of transportation from ships to railways; and it is evident that air attacks on the cities around Tokyo Bay contributed only in a minor way to the disruption of rail transportation. There were no figures available for rail-borne commodities in the complex.

Damage to Railway Installations. Physical damage due to air attacks was not sufficient to curtail rail shipments at any time. Railway stations within the cities were hit, and one of Tokyo's three main freight yards was damaged, while a few locomotives and some rolling stock were lost. Obsolescence and lack of repair parts incapacitated much of the equipment, and a shortage of trucking facilities and freight handlers at times further delayed rail movements. In general, however, it was the inadequacy of the entire rail system, as it was with shipping, that hastened the final collapse in the urban economy of the Kanto Plain. This inadequacy cannot, however, be attributed even indirectly to air attacks on the cities.

Trucking. The amount of goods coming into the urban complex by trucks was generally twice that of outgoing commodities, the main imports being metals, food, and building materials, with fuel leading the list of exports. Unclassified military goods and other commodities accounted for more than half of both incoming and outgoing trucking. Accurate data on the amount of goods

moved by trucks could be obtained only from August 1944; but it is evident from these figures that bombing had a drastic effect on this form of transportation (Graph 4). From a peak of more than 639,000 tons in January 1945, incoming truck freight dropped to a little over 331,000 tons the following month, while outgoing freight was reduced from approximately 302,000 tons to 158,000 at the same time. Prior to the raid period, incoming tonnage had fluctuated between 529,000 and 639,000 tons and outgoing tonnage between 313,000 and 380,000 tons. In July, the categories had reached the low figure of 218,000 and 128,000 tons, respectively. Table 11 shows the average monthly tonnage during the pre-raid months, August 1944 through January 1945, and the average percentage of decline during the raid period, February through July 1945.

TABLE 11.—*Monthly average of truck-borne commodities*
[Metric tons]

Commodity	Preraid incoming	Percent loss in raid period	Preraid outgoing	Percent loss in raid period
Metals_____	79,394	50	49,618	69
Fuel_____	17,737	19	48,745	36
Building materials_____	48,222	62	11,341	60
Machinery_____	12,009	4	9,007	4
Food_____	57,326	41	2,058	30
Military goods_____	203,595	46	146,846	52
Others_____	160,660	57	70,250	49
Total_____	578,943	49	337,865	50

Source: Trucking Control Assn.

Damage to Trucking Facilities. At the beginning of 1944 there was an estimated total of 15,000 trucks available to Kokyo, Kawasaki, and Yokohama, however, owing to wartime attrition, lack of replacement parts and a shortage of trained mechanics, only half of them were in use at the time. Even the operative vehicles could not be employed to full capacity because of shortages of gasoline, oil, and tires. An indication of the inadequacy of trucking facilities is given in the fact that only 30 percent of legitimate orders could be filled in Tokyo prior to air attacks. Bombing further reduced the number of operating trucks to about 2,200; and although 300 were put back into service after repairs had been effected, the number of vehicles in good condition was far from sufficient to meet current needs. It is evident from the sudden drop in freight movements coincident with the destruction of vehicles, that air attacks were directly responsible for the decline in truck transportation.

Local Transportation. There are no accurate data on the number of busses and streetcars in the three cities, but according to official estimates, 15 percent of the trolleys and 60 percent of the buses were immobilized prior to the raid period owing to lack of repair facilities. It is further estimated that approximately 45 percent of the streetcars and 10 percent of the buses were destroyed by bombings. Passenger traffic decreased about 50 percent during the raid period but this was due as much to a reduced population as to the loss of vehicles. Local trucking was inadequate for city freight transportation, and was at times responsible for slow-downs in both rail and water-borne movements.

Fuel. The fuels used in the urban areas of the Kanto Plain were, in order of importance, coal, coke, charcoal, and oil. Normally, about 50 percent of the coal supply was imported from the Ishikari fields of Hokkaido, and about 30 percent from the Joban field north of Tokyo. The remainder came from southern Japan and Korea. The urban complex of Tokyo, Kawasaki, and Yokohama was normally self-sufficient in coke production, practically all of its needs being supplied by the Tokyo Gas Co., with plants in the three cities. Most of the charcoal was produced by small hand-operated furnaces scattered throughout the forested mountain districts, about 72 percent of the local supply coming from Tohoku, the northern section of Honshu. Fuel oil was used relatively little, and all of it had to be imported from abroad.

Coal. About 65 percent of the coal used in the urban complex was bituminous, most of it being shipped in from Hokkaido. This type of coal was used primarily in the production of coke and gas. Both bituminous coal and lignite were employed for steam generation in industrial plants, while anthracite, representing only about 4 percent of all coal consumed in the area, was converted almost exclusively to briquettes for heating purposes. Industry normally accounted for about 82 percent of all coal consumed in the three cities, with utilities using about 7 percent. The principal industrial consumer was the metals production industry, with metal products, machinery, and chemicals following in that order. The consumption of coal by utilities was almost exclusively for the production of gas and its by-product coke.

Coal Shortages. Coal was allocated on the basis

of priorities, the producers of steel being considered the most vital consumers; but allocations were never fulfilled in any category after the beginning of 1944. Prior to September of that year, only 70 to 80 percent of the allotted coal was actually received; between September and December receipts dropped to 50 percent, and thereafter to only 30 percent of allocations. The use of coal for domestic and public heating was prohibited after March 1944; and many of the smaller industries, such as textiles and food processing, began to use wood as fuel. The principal reason for coal shortages was the lack of transportation. Shipping losses and the submarine blockade effectively stopped shipments into Tokyo Bay and threw the burden of transportation on the already overworked and inadequate railways. After October 1943, 70 percent of the coal from Hokkaido came in by rail, the remaining 30 percent being shipped through Japan Sea ports. From March 1944 on, the movement of lignite from southern Honshu was discontinued because of a shortage of rail facilities, and after May 1945 there were no further imports from Korea and Kynshu. Finally, the Navy strike of June 1945 against Hakodate and Aomori destroyed the ferries plying between Hokkaido and Honshu and brought rail transportation of coal into Tokyo from the north to a complete stop.

Coal Consumption. Statistics for coal consumption in the three cities were obtainable only as far back as April 1944, but it is evident that the decline had set in long before that month. Coal consumption in industry, the major consumer, declined steadily during the entire period, there being no marked fluctuations occurring at the time of air attacks (Graph 5). From a total of 420,800 tons in April 1944, consumption in the area dropped to 134,600 tons in July 1945. Table 12 shows the average amount of coal consumed in the various categories in the three cities during the preraid months, April 1944 through January 1945, together with the decline during the raid period, February through July 1945.

Coke. Highest priorities in the use of coke were given to the aircraft parts and munitions industries. Bomb damage to coking plants was relatively light; consequently there was no decline in production from this cause. Shortages, which existed primarily in the low priorities category of consumer, were due almost exclusively to the dif-

TABLE 12.—*Coal consumption*
[Metric tons]

Period	Consumption			
	Industry	Utilities	Others	Total
Tokyo:				
Pre-raid_____	73,590	23,580	34,890	132,060
Raid_____	28,716	12,716	28,866	70,298
Percent of decline	61	46	17	47
Kawasaki and Yokohama:				
Pre-raid_____	200,850	1,830	3,160	205,840
Raid_____	115,835	1,515	2,683	120,033
Percent of decline	42	17	15	42
Total:				
Pre-raid_____	274,440	25,410	38,050	337,900
Raid_____	144,551	14,231	31,549	190,331
Percent of decline	47	44	17	44

Source: Japan Coal Association.

ficulty in importing the raw material, coal. Relief was given to certain vital plants by the importation of coke from Hokkaido during the last quarter of 1944 but there was seldom sufficient to meet current needs thereafter. Domestic use of the fuel was discontinued in October 1944, after an especially precipitous drop in production.

Coke Consumption (Graph 6). Consumption fluctuated between 39,300 and 42,200 tons monthly from October 1943 through September 1944. In October, it dropped sharply to a little above 28,000 tons, but the importation of Hokkaido coke brought it back to average during the months of November and December. In January 1945, a permanent decline set in, and by July monthly consumption had reached a low of slightly over 15,500 tons. Here, again, as in the case of coal, sudden drops did not coincide with the occurrence of air attacks, difficulties in transportation exercising the decisive effect on supply. Table 13 shows the monthly averages of coke consumption during the pre-raid and raid periods, and the decline registered during the latter months:

Charcoal. Approximately 79 percent of all charcoal in the area was consumed domestically, industry accounting for only 16 percent. The remainder was used principally as motor fuel in civilian vehicles and in public baths. Monthly fluctuations in the use of charcoal were highly erratic, but in general the trend followed normal seasonal requirements (Graph 7). The January 1944 peak of 28,422 tons for all uses had declined to 21,636 for the same month of 1945, while the seasonal low point of 8,891 tons in October 1944 had reached 3,854 by July 1945. This over-all

TABLE 13.—*Coke consumption*
[Metric tons]

Period	Consumption			
	Industry	Utilities	Others	Total
Tokyo:				
Pre-raid-----	13,076	2,818	312	16,206
Raid-----	9,762	1,182	150	11,094
Percent of decline-----	25	58	52	31
Kawasaki and Yokohama:				
Pre-raid-----	19,668	1,898	163	21,729
Raid-----	7,193	861	5	8,059
Percent of decline-----	63	55	97	63
Total:				
Pre-raid-----	32,744	4,716	475	37,935
Raid-----	16,955	2,043	155	19,153
Percent of decline-----	48	57	67	50

Source: Japan Coke Association.

decline was due perhaps as much to the destruction of homes and the consequent decrease in demand as to the lack of transportation facilities for the delivery of this fuel. The whole charcoal situation, however, had little effect on the economy of the complex. Table 14 shows the average monthly consumption during the pre-raid and raid periods:

TABLE 14.—*Charcoal consumption*
[Metric tons]

Period	Homes	Industry	Other	Total
Pre-raid-----	13,277	2,933	466	16,676
Raid-----	6,932	2,138	303	9,373
Percent of decline-----	48	27	35	44

Public Utilities. The entire utilities system of Tokyo, Kawasaki and Yokohama formed one integrated network within the urban complex and, to a certain extent, throughout the Kanto Plain. Electricity was supplied to the whole area from hydroelectric plants in the mountain regions through a series of substations in or near the cities, only about 20 percent of the power being furnished by auxiliary coal-powered stations within the municipalities. Thus, bombing of the urban areas themselves could not effectively disrupt the supply of electric power or destroy the installations which produced it. Gas, on the other hand, was produced within the urban complex, and depended exclusively on the ever diminishing supply of coal. Installations were also highly vulnerable to air attacks, as they were located mainly in built-up industrial areas. Steam power, furnished almost solely by Kawasaki, suffered from the same shortages and vulnerability as the gas supply, but the water system, with its outlying reservoirs and underground mains, was not sus-

ceptible to serious disruption through incendiary raids on the cities.

Electricity. At the beginning of 1944, the total electric power capacity available to the three cities was 2,061,222 kilovolt-amperes. By the end of the raid period, this had been reduced to 1,722,022, a loss of almost 17 percent. In Tokyo alone, 66 substations were damaged, transmission lines were broken in 483 places, and 33 power line supports were wrecked. Very little was done, however, to restore any but the most vital of the damaged installations, which were rapidly repaired, as the need had been reduced considerably through bomb damage to consumer facilities. There is no information available on physical damage in Kawasaki and Yokohama, but as a shortage of electric power was not reported in these two cities, it may be assumed that any disruption experienced there was of minor importance and did not materially affect an adequate supply of electricity.

Electric Power Consumers. Japanese records cover only three categories of electric power consumption: (1) lighting, both private and public, (2) installations, industrial or otherwise, having a capacity of 50 kilowatt of power or less, and (3) installations having a capacity of more than 50 kilowatts. As domestic use of electricity for purposes other than lighting represents less than 3 percent of the second category, this factor is ignored in the present analysis. Similarly, power requirements of nonindustrial installations are insignificant, and consumption by railways is not included in the assembled statistics. Normally, 83 percent of all electric power output went to industries with a capacity of 50 kilowatts and over, while 7 percent was consumed by installations of less than 50 kilowatt capacity. It was found from a comparison of data for Japan as a whole that plants of less than 50 kilowatt capacity generally employed fewer than 50 workers, while those of over 50 kilowatts employed more than 50 workers. Thus, for the sake of brevity, industry is here referred to as small or large on the basis of the above figures for electric power consumption and labor force.

Electric Power Shortages. Prior to November 1944, electricity was limited to a certain extent among the less important consumers, owing to a diminution in the water flow at the hydroelectric plants and the irregularity of the coal supply locally. The use of electricity was curtailed for lighting and cooking and prohibited for heating

during the winter months of 1942-43 and 1943-44. Highest priorities went to plants manufacturing products directly for the armed forces, while second priorities were held by those industries indirectly serving the military. Very few large industries generated their own power, as most private generators had been transported to southern Asia by government order. At no time, however, was there a critical shortage of electric power; and even minor shortages ceased by the end of 1944, when air attacks began to reduce power needs through damage to consumer facilities.

Electric Power Consumption (Graph 8). During the preraid period, October 1943 through January 1945, total electric power consumption for all categories fluctuated between 250 million and 310 million kilowatt-hours monthly, the low point being registered during the summer of 1944. By July, 1945, however, total consumption had declined to around 123 million kilowatt-hours. Electricity for lighting purposes was naturally most affected, owing to diminished seasonal needs and the black-outs then in force. Consumption in small industries was reduced first by the closing and consolidation of small plants and later by destruction due to bombing. Evidence of this was found in Tokyo, where the number of small consumers decreased from 92,000 in October 1943 to 78,000 in January 1945, and to 25,000 by July 1945, representing a decline of 15 percent prior to air attacks and a further decline of 58 percent during the raid period. Over the same period, installed capacity in small industries was reduced from 375,000 kilowatts to 354,000 kilowatts pre-raid, and to 118,000 kilowatts by the end of the raid period, or 6 percent and 63 percent, respectively. Most of the decline in the second period was due to bomb damage to facilities, as a large portion of the small industrial installations were located in the devastated areas. The larger plants suffered considerably less from bombing, partly because many of them were located on the periphery of the cities, and partly because their more solid construction was less vulnerable to incendiary attacks. The consumption decline in large industries was due to curtailed production caused by shortages of coal and raw materials rather than to a loss of electric power capacity. In general, supply of electricity was adequate for all demands in all categories of consumers. Table 15 shows the average monthly consumption of electricity prior to

air attacks, and the decline during the raid period.

TABLE 15.—*Electric power consumption* [1,000 kw.h.]

Period	Light	Power (under 50 kw.)	Power (over 50 kw.)	Total
Tokyo:				
Pre-raid.....	23,820	16,307	148,075	188,202
Raid.....	15,889	9,077	88,507	113,473
Percent of decline	33	44	40	40
Kawasaki and Yokohama:				
Pre-raid.....	4,242	3,013	74,534	81,789
Raid.....	2,892	1,929	43,392	48,213
Percent of decline	32	36	42	41
Total:				
Pre-raid.....	28,062	19,320	222,609	269,991
Raid.....	18,781	11,006	131,899	161,686
Percent of decline	33	43	41	40

Source: Kanto Haiden (Distributing) Co.

Gas. All of the gas used in Tokyo, Kawasaki, and Yokohama was produced by eight plants in the three cities, with a total pre-raid capacity of around 48 million cbm monthly, distributed as follows:

City	Number of plants	Monthly production (cubic meters)
Tokyo.....	4	17,411,000
Kawasaki.....	1	8,222,000
Yokohama.....	3	22,730,000

The average monthly consumption during the same period, February 1944 through January 1945, was approximately 42 million cbm, or 87 percent of capacity. The supply of gas was short during the entire period of the war, and subject to numerous restrictions. Its use for heating was prohibited, and home consumption for cooking was strictly limited. As the supply of coal diminished it became increasingly difficult to meet the urgent requirements of war industries as well as to provide for minimum domestic needs. There was also a serious shortage of replacement parts, and the loss of trained workers through military conscription and general absenteeism handicapped both plant operation and repair work.

Damage to Gas Plants. Damage to plant facilities by air attacks was considerable. Of the four producers in Tokyo, one was completely destroyed and two others damaged, the greatest destruction occurring in the raid of 10 March 1945. The two largest plants in Yokohama were badly damaged in the raid of 29 May, while the Kawasaki works suffered loss of production mainly because of lack of maintenance. During the raid period, according to the Gas Control Corp., total capacity for the

three cities was reduced by almost half, while over-all monthly consumption declined 55 percent. Thus, air attacks had the effect of relieving the gas shortage by destroying the demand, chiefly in the domestic category.

Gas Consumption (Graph 9). From a peak of over 49 million cubic meters in March 1944, consumption dropped to slightly under 36 million in February 1945, just prior to the first damaging area raid. Thereafter, the decline was greatly precipitated, reaching a low of 5.6 million cubic meters in July, the greatest drop occurring between March and May. As these were the months of heaviest air attacks, the decline was due to a physical decrease in both producer and consumer capacity, although production was still comfortably in excess of consumption during the last 4 months of the war. Table 16 shows the monthly preraid averages of consumption, and the decline during the raid months.

TABLE 16.—*Gas consumption*
(1,000 cubic meters)

Period	Industry	Homes	Other	Total
Tokyo:				
Pre-raid_____	15,310	16,720	3,034	35,064
Raid_____	7,731	5,566	840	14,137
Percent of decline___	50	67	72	60
Kawasaki:				
Pre-raid_____	3,329	416	38	3,783
Raid_____	1,887	236	21	2,144
Percent of decline___	43	43	45	43
Yokohama:				
Pre-raid_____	2,553	783	68	3,404
Raid_____	2,124	651	56	2,831
Percent of decline___	17	17	18	17
Total:				
Pre-raid_____	21,192	17,919	3,140	42,251
Raid_____	11,742	6,453	917	19,112
Percent of decline___	45	64	71	55

Source: Gas Control Corp.

Water. There was no shortage of water either prior to or during the raid period, in spite of minor breaks in the system. Information merely discloses that the use of it in firefighting was generally ineffectual because of the intensity of incendiary attacks. In Tokyo, where raids were most damaging, consumption of water dropped from a pre-raid monthly average of 27 billion liters to 9 billion in June 1945. Industrial consumption represented 41 percent of the total. This decline was due exclusively to a decrease in demand caused by destruction of consumer facilities.

Manpower. According to the national census of February 1944, the total labor force of the three

cities, including student workers, amounted to 3,559,321, or 11 percent of all gainfully employed persons in Japan. Of this number, 1,542,735, or 43 percent, were employed in industry, and 201,268, or 6 percent were engaged in wholesale and retail trade. This compares with 30 percent and 7 percent in the two categories for the nation as a whole (Graph 10). From the peak figure of 1,793,526 in November 1944, the total industrial labor force declined to 712,587 in July 1945, the sharpest drop being registered between January and March 1945 in the loss of over 600,000 workers. The tremendous decrease in Tokyo, which suffered the greatest destruction of property, was offset somewhat by a shift of workers to the other two cities. Table 17 gives the average monthly total of industrial workers in the three cities, together with the percentage of decrease or increase during the raid period. It was impossible to obtain figures for other categories of employment.

Manpower Shortages. In practically all categories of employment there were some complaints of shortages of skilled workers. Women and students were added increasingly to the labor market, small industries were consolidated or closed out entirely and trade establishments were shut down in order to fill the labor gap left by the conscription of able-bodied men into the armed forces. Chinese and Koreans were brought in to increase the supply of manual workers, and soldiers were sometimes put into service to overcome a temporary lack of manpower in transportation and communications. In February 1944, 30 percent of the 1,287,258 full-time factory workers in the three cities were women; but as females were favored in evacuations following the heavy area raids, this figure had been reduced to 26 percent by July 1945. Children represented 5.6 percent of the total industrial labor force prior to air attacks; but presumably this class of worker was also favored in the evacuations. The final closing of all schools in the area took place in the summer of 1944, and from that time on approximately 95 percent of the more than half a million students formed a substantial part of the labor force. Thus, while there was no shortage in the actual number of workers required for all categories of employment, their lack of training and constant shifts from one job to another could not but have a harmful effect upon the already collapsing economy of the complex. The air attacks further reduced the efficiency of workers by increasing absenteeism, while

TABLE 17.—*Industrial labor force*

Period	Full-time workers			Part-time	Clerks	Total workers
	Male	Female	Total			
Tokyo:						
Pre-raid	860,386	352,913	1,213,299	30,106	197,665	1,441,070
Raid	409,469	165,096	574,565	11,491	93,581	679,637
Percent of decline	52	53	53	62	53	53
Kawasaki:						
Pre-raid	62,411	29,444	91,855	6,589	13,778	112,222
Raid	75,076	28,736	103,812	7,103	15,571	126,486
Percent of decline	(17)	2	(12)	(7)	(12)	(11)
Yokohama:						
Pre-raid	87,340	37,171	124,511	8,993	18,819	152,323
Raid	89,999	37,990	127,989	8,391	19,199	155,579
Percent of decline	(3)	(2)	(3)	7	(2)	(2)
Total:						
Pre-raid	1,010,137	419,528	1,429,665	45,688	230,262	1,705,615
Raid	574,544	231,822	806,366	26,985	128,351	961,702
Percent of decline	43	45	44	41	44	44

Source: Ministry of Welfare.
Figures in parentheses are increases.

adding to the idle labor force through the destruction of productive facilities. The critical situation in labor seems to have been caused primarily by the lack of any well-organized official planning and the resultant inequitable distribution of manpower to meet both military and civilian needs.

Labor Efficiency. Normally, Japanese industrial workers were expected to perform 270 hours of productive labor per month. In Tokyo, Kawasaki and Yokohama, however, workers were averaging only 222 productive hours during the pre-raid months. Labor productivity had therefore already decreased 18 percent prior to air attacks on the complex. During the period of the raids, average monthly productive hours were reduced to 117, representing a decline of 47 percent from the preraid average. According to information available, this decline was due partly to air attacks and partly to curtailed production caused by lack of raw materials and fuel. Loss of efficiency was further occasioned by the necessity for employing untrained workers in skilled occupations, and by the general letdown in morale as a result of adverse economic conditions. Table 18 gives the monthly average of productive hours per worker prior to and during the raid period.

Trade. Very little information could be obtained concerning wholesale and retail trade in the three cities. As foreign sources of supply were cut off and local commerce diminished, the number of workers and trade establishments drastically decreased; and the 900,000 men and women employed in commerce in October 1940 had already

TABLE 18.—*Labor efficiency*

Period	Factory workers	Productive hours	Hours per worker
Tokyo:			
Pre-raid	1,213,299	274,858,500	227
Raid	574,565	66,952,100	117
Percent of decline	53	76	48
Kawasaki and Yokohama:			
Pre-raid	216,366	43,299,500	200
Raid	231,801	27,475,800	119
Percent of decline	(7)	37	40
Total:			
Pre-raid	1,429,665	318,158,000	223
Raid	806,366	94,427,900	117
Percent of decline	44	70	48

Basic data from Ministry of Welfare.
Figures in parentheses are increases.

been reduced to 200,000 by February 1944. Sales and distribution units were taken over by the government and used to implement its rationing system. Data on commercial employees during the raid period were obtainable only for Tokyo, and in this city (which accounted for the greater portion of this category of workers) their number had been reduced to 60 percent from November 1944 to the end of May 1945. This decrease was due in great part to bomb damage to shops and stores, as the official combing-out process had reached its peak prior to the raid period. The over-all shortage of wholesale and retail outlets had no serious effect on the economy of the area, however; the decline in the production of consumer goods had for the most part rendered them unnecessary.

Industrial Production. While it was impossible

to obtain detailed production statistics for the city as a whole, the over-all data available, from January 1944 to August 1945, serve to point up the trend for industry in general (Graph 11). During the pre-raid period, total production amounted to a monthly average of 453.4 million yen, 86 percent of which was for military purposes. The decline in civilian production had already set in by October 1944, but it was not until January 1945 that military production, and hence the over-all industrial output, began its precipitous drop. The rapid decline was checked momentarily in May and June at around 155 million Yen, but continued downward through July, reaching the low point of a little less than 118 million Yen in that month. This represented an average decrease of 54 percent from the pre-raid period. At the same time, full-time factory employment decreased only 44 percent, while productive hours declined 70 percent. One of the most vital factors in industrial production, for which over-all statistics were not obtainable, is the supply of raw materials and component parts; but as these items depended upon the increasingly inadequate transportation system, there was generally a critical shortage of the materials required by the factories in the complex for conversion to finished products. The direct effects of bombing on industrial installations are shown in the section on industrial production.

Economic Collapse Coincident with Air At-

tacks. While it is difficult at this point to measure the direct effects of air attacks on the over-all economy of the area encompassing Tokyo, Kawasaki and Yokohama, it is of some value to compare the decline of contributing factors during the raid period. Table 19 gives the average monthly figure for each industrial factor during the pre-raid and raid periods and for the last full month of the war, together with the percentages of decline.

From these figures it would appear that shipping, showing the greatest decline, was the primary cause for the decrease in production, as most of the other contributing factors show less of a decline than industrial output. If, however, electric power consumption be taken as the measure of production (as yen value here merely represents sales), it will be seen that almost all the other factors likewise contributed in large measure to the ultimate collapse. Bomb damage itself, with its resultant destruction of physical installations, would have brought all factors to the same decreased level as production itself, however, it did not do so. The conclusion may therefore be drawn that destruction of a portion of the physical means of production merely reduced the excess capacity of plants, and contributed less to the decline in industrial output than did the indirect effects of air attacks. This seems to be borne out by the fact that little or no repair was undertaken by those factories which actually suffered bomb damage.

TABLE 19.—*Decline in industrial factors*

Factor	Monthly averages		Percent average decline	July 1945	Percent total decline
	Pre-raid	Raid			
Incoming shipping (gross rated tons) _____	279,620	75,110	73	25,271	91
Incoming trucking (tons) _____	578,943	293,554	49	218,184	62
Coal consumption (tons) _____	274,440	144,551	47	99,210	64
Coke consumption (tons) _____	32,744	16,955	48	13,985	57
Charcoal consumption (tons) _____	2,933	2,138	27	1,883	36
Electric power (1,000 kilowatt-hours) _____	241,929	142,905	41	109,127	55
Gas consumption (1,000 kilowatt-hours) _____	21,192	11,742	45	4,394	79
Factory workers _____	1,429,665	806,366	44	595,031	58
Industrial production (1,000 yen) _____	453,410	207,632	54	117,890	74

INDUSTRIAL PRODUCTION

Industrial Plant Sample. In order to undertake a more detailed analysis of industrial activity than was possible from the over-all data assembled for the urban complex, questionnaires were sent to some 1000 plants in Tokyo, Kawasaki, and Yokohama. Of these, 516 were returned with statistics complete enough to establish a valid industrial sample for the area. The following list gives the industrial classifications used throughout this study, together with the number of plants completing the questionnaire in each industry group:

Category	Industry	Number of plants
1-----	Aircraft and alternating-current engines	17
2-----	Ordnance-----	23
3-----	Shipbuilding-----	22
4-----	Motor vehicles-----	19
5-----	Electrical products-----	76
6-----	Machinery and tools-----	81
7-----	Metal products-----	74
8-----	Metals production-----	70
9-----	Chemicals-----	53
10-----	Petroleum-----	4
11-----	Miscellaneous (textiles, leather, etc.)-----	75
12-----	Public utilities-----	2

Value of Plant Sample. Though the questionnaires were directed only to plants employing 100 or more workers, the returns represented 37 percent of the industrial electric power consumption, 32 percent of the industrial labor force, and 31 percent of the productive labor hours accounted for by the entire complex prior to the period of air attacks. Thus, it may be assumed that the sample represents about one-third of the total industrial capacity of the area under wartime conditions. The plant sample is compared with data for the entire complex as follows:

	Productive hours	Labor force	Electric power
Complex-----	318,158,000	1,429,665	241,929,000
Sample-----	97,569,000	451,754	90,154,000
Percent-----	31	32	37

Significance of Industrial Factors. The measure of industrial production is ordinarily understood to be the value of work in process during a given accounting period. Usually in Japanese data the yen value of finished products, or deliveries, reflects output with fair accuracy, but in certain industries, the measure of monthly fluctuations in actual production must be sought in

factors more immediately susceptible to wartime economic conditions. This is particularly true in the Tokyo-Kawasaki-Yokohama complex, where shipbuilding and heavy machinery were important items in the industrial output. A more sensitive gage of the immediate reactions of production is found in either the electric power consumption of plants or the productive hours of labor, or both, since these factors would immediately reflect the consequences of material shortages and the impact of air attacks. It was found upon examination that total labor hours, productive and lost, are a constant multiple of the total labor force in each industry, and may be used as an accurate measure of fluctuations in the number of plant workers.

NOTE.—After the graphs for this section of the report had been drawn, it was discovered that several plants had represented their labor force as man-days; therefore, the decline in labor force is represented hereafter by that of total labor hours. However, for the purpose of establishing an accurate value for the sample, labor force figures were adjusted in the comparative table.

Ratios of Production Factors. Industry places a predominant reliance on either hand labor or electric power; and in plants which are primarily concerned with assembly, one may be partially or wholly substituted for the other. Thus, a decrease in electric power consumption in relation to productive hours would indicate either an increasing use of unskilled workers (men untrained in the operation of complicated power-driven machines), resulting in a decreased demand for electric power, or immobilization of the machines themselves through damage, obsolescence or lack of maintenance. In the basic metals industry, however, electric power consumption is not so much dependent on skilled labor as on the supply of raw materials, as even untrained workers might be employed to operate the furnaces. The efficiency of labor can be determined from the ratio of productive hours to kilowatt hours; and labor productivity can be measured by the rate of yen sales per productive hour. The ratio of kilowatt-hours to sales may be used as a further check on labor efficiency and productivity. Finally, in determining the cause of production declines, the percentage relationship of each industrial group to the total of the sample must be taken into consideration.

Limiting Factors in Production. The 516 sampled plants in the urban complex reported a variety of reasons for the decline in production during the period under survey. The chief causes

for the over-all decline, in order of frequency and importance, were: (1) labor difficulties, (2) shortages of raw materials, and (3) shortages of fuel. Bomb damage as a direct cause of production losses was cited seventh on the list. A word of clarification is necessary, however, in order to understand the significance of these limiting factors and their relationship to one another. The labor problem cannot be interpreted merely as a shortage of plant workers. It consisted rather in absenteeism, induced by the need of workers to care for their families and repair their homes during the period of devastating area raids, and by the necessity for seeking food in distant rural areas after air attacks had disrupted the rationing system in the cities. Absenteeism was further increased by the disruption and inadequacy of local transportation, likewise the result of air attacks, and the efficiency of the workers was lowered and their productivity lessened as a result of the undermining psychological effects of frequent bombings. Though shortages of skilled workers occurred in some industries, there was at no time a critical lack of manpower in the plants except through absenteeism. Thus, air attacks may be said to have been the primary cause, even though indirectly, of the decline in industrial production after the end of 1944. On the other hand, shortages of raw materials, component parts and fuel (gas and coal) had been the principal limiting factors prior to the raid period, and continued to play an important part in reducing output during the succeeding months. As we have already seen, these shortages were due primarily to the Allied blockade, and the antishipping program, and to the inadequacy of the Japanese allocations and transportation system. While air attacks destroyed numerous small workshops and temporarily disrupted production in many of the larger plants, the reporting industries escaped major destruction of their facilities. The only other limiting factors worthy of mention were: official orders changing the nature or model of end products; changes in the requirements of customers, and dispersal.

Periods of Limitation. Shortages of fuel existed as early as 1943, owing to drastic enemy-induced restrictions on shipping, and continued to be the primary limiting factor on production until March 1944. From April to October, although peak production was attained during this

period, raw materials were the bottleneck but from November 1944 until the end of the war the effects of air attacks minimized the shortages through an increase in absenteeism at the plants and a further slow-down in production through the necessary use of untrained workers in skilled categories. Both raw materials and fuel, however, remained short throughout the entire raid period. While official orders and changes in customer demands slowed production in almost every industry prior to the period of air attacks, these factors became less pronounced during the raid months. Dispersal was important only in the aircraft industry, which began its program as early as August 1944, though early in 1945, transfers of plant and equipment began to take place to a certain extent in almost every industry. The following list shows the relative importance of the limiting factors of production in each of the industrial groups in both the pre-raid and raid periods:

Reasons given for decline in production

Industry	Pre-raid period	Raid period
1. Aircraft-----	1. Labor. 2. Official orders. 3. Change in demand.	1. Labor. 2. Dispersal. 3. Bomb damage.
2. Ordnance-----	1. Raw materials. 2. Labor. 3. Official orders.	1. Fuel. 2. Component parts. 3. Labor.
3. Shipbuilding----	1. Labor. 2. Official orders. 3. Change in demand.	1. Labor. 2. Change in demand. 3. Official orders.
4. Motor vehicles--	1. Labor. 2. Official orders. 3. Fuel.	1. Labor. 2. Official orders. 3. Fuel.
5. Electrical products.	1. Raw materials. 2. Labor. 3. Change in demand.	1. Labor. 2. Raw materials. 3. Fuel.
6. Machinery and tools.	1. Raw materials. 2. Change in demand. 3. Labor.	1. Labor. 2. Raw materials. 3. Fuel.
7. Metal products--	1. Labor. 2. Change in demand. 3. Official orders.	1. Labor. 2. Raw materials. 3. Change in demand.
8. Metals production.	1. Raw materials. 2. Labor. 3. Fuel.	1. Raw materials. 2. Labor. 3. Fuel.
9. Chemicals-----	1. Raw materials. 2. Fuel. 3. Change in demand.	1. Raw materials. 2. Fuel. 3. Labor.

Reasons given for decline in production (continued)

Industry	Pre-raid period	Raid period
10. Petroleum----	1. Raw materials. 2. Labor. 3. Fuel.	1. Raw materials. 2. Dispersal. 3. Fuel.
11. Miscellaneous--	1. Labor. 2. Change in demand. 3. Fuel.	1. Labor. 2. Fuel. 3. Bomb damage.
12. Public utilities (gas).	1. Raw materials. 2. Labor. 3. Fuel.	1. Raw materials. 2. Labor. 3. Fuel.
All industry----	1. Raw materials. 2. Labor. 3. Fuel.	1. Labor. 2. Raw materials. 3. Fuel.

Over-all Production Trends. For the purpose of this study, the months October 1943 through September 1944 have been established as the base period, all percentages being calculated on the average monthly figure for this full pre-raid year (Graph 12). Prior to the period of air attacks, sales rose steadily from 352.2 million yen in November 1943 to a peak of 494.9 million in October 1944. From the latter month, however, the trend was steadily downward, with sales reaching the low figure of 140 million yen in July 1945, the last full month of the war. This represented a total drop of 66 percent from the base period average of 405.9 million yen. Electric power consumption fluctuated between 86 and 96 million kilowatt-hours during the pre-raid months, with a base average of 90.2 million. The decline in this factor began in December 1944, consumption falling off gradually to 35.4 million kilowatt-hours in July 1945, a decrease of 61 percent. Productive labor hours increased from 86 million in October 1943 to 113.3 million in November 1944, the average for the base period being 97.6 million. In January 1945, however, productive hours dropped below normal and continued to decrease gradually to 47 million in July, representing a decline of 52 percent. The labor force as represented by total labor hours, dropped only 13 percent during the raid period. The most significant decline in production occurred in April 1945, when yen sales fell off 28 percent. That this was an accurate reflection of the actual drop in production is attested by the fact that both electric power consumption and productive hours registered their greatest decreases in the same month—16 percent and 15 percent, respectively.

Causes of Decline in Production. While productive labor hours represented 79 percent of the

total labor hours during the pre-raid period, by July 1945 they were only 44 percent of the total. Conversely, lost hours increased from 21 percent to 56 percent. During the same months, sales dropped from 4.17 yen per productive hour to 2.98, and kilowatt-hours per productive hour decreased from 0.93 to 0.75. Yen sales per kilowatt-hours declined from 4.48 to 3.96. As the labor force had decreased only 13 percent during the same period, compared with a drop of more than 50 percent for other factors of production, it is evident that there was no actual shortage of workers. As we have seen in the section on Economic Effects of Air Attacks, there was likewise no shortage of electric power; therefore, the decline in this factor must have been due to diminished needs on the part of consumers. We find, however, that productive hours per total hours decreased 35 percent, an indication that labor was not devoting full time to its normal functions; and a decrease of 29 percent in yen sales per productive labor hour is evidence of the diminishing productivity of workers either through lack of training or absenteeism. This is further borne out by the fact that electric power consumption per productive hour had fallen off 19 percent, indicating an increasing reliance on workers as against the use of machinery. Yen sales per kilowatt-hours had declined 11 percent, from which it may be deduced that untrained labor was becoming more and more an obstacle to the effective maintenance of production standards. This analysis upholds the reporting plants in their declarations that labor was the principal limiting factor of industrial production during the raid period. Such being the case, it is obvious that even had more materials and fuel been available, the continued inefficiency of the workers would have prevented any appreciable increase in output, and the ultimate decline in production would not have been measurably altered. The influence of each industrial group on production as a whole is shown in Table 20.

Decline Attributable to Individual Industries. Although the rate of decline in factors within the separate industrial categories is a measure of production losses of individual industries, it is important to evaluate the contribution of each group to the decline in industry as a whole. Table 21 shows the percentage of the loss in each industry in relation to the total loss for all plants in the sample:

TABLE 20.—*Decline in industrial factors during raids*
[Units in 1,000]

Industry Group	Yen sales					Productive hours					Kilowatt-hour consumption				
	Base	Per-cent	July	Per-cent	Loss per-cent	Base	Per-cent	July	Per-cent	Loss per-cent	Base	Per-cent	July	Per-cent	Loss per-cent
1-----	45,236	11	6,873	5	85	9,477	10	4,503	10	52	4,714	5	1,371	4	71
2-----	7,945	2	5,640	4	29	4,178	4	2,661	6	36	1,027	1	481	1	53
3-----	28,010	7	12,362	9	56	10,665	11	3,383	7	68	3,904	4	1,610	5	59
4-----	22,290	6	4,638	3	79	7,633	8	4,707	10	38	4,158	5	1,441	4	65
5-----	68,817	17	24,927	18	64	14,637	15	6,772	14	54	7,844	9	3,111	9	60
6-----	53,545	13	22,328	16	58	14,288	15	4,174	9	71	5,195	6	2,880	8	45
7-----	21,265	5	7,813	6	63	6,737	7	3,470	7	48	3,487	4	937	3	73
8-----	66,690	16	27,454	19	59	13,097	13	7,206	15	45	35,719	39	12,169	35	66
9-----	29,736	7	13,905	10	53	8,954	9	5,131	11	(78)	12,493	13	4,693	13	62
10-----	1,514	1	90	0	94	274	0	488	1	43	525	1	97	0	82
11-----	57,848	14	12,670	9	78	7,492	8	4,463	10	40	9,056	10	5,288	15	42
12-----	3,489	1	1,395	1	60	137	0	115	0	16	2,332	3	1,166	3	50
Total	406,394	100	140,095	100	66	97,569	100	47,073	100	52	90,154	100	35,244	100	61

Figures in parentheses are increases.

TABLE 21.—*Comparison of declines in industrial groups*
[Units in 1,000s]

Industry	Yen sales		Productive hours		Kilowatt-hour consumption	
	Loss	Per-cent	Loss	Per-cent	Loss	Per-cent
1-----	38,363	14	4,974	10	3,343	6
2-----	2,305	1	1,517	3	346	1
3-----	15,648	6	7,282	14	2,294	4
4-----	17,661	7	2,926	6	2,717	5
5-----	43,890	16	7,865	16	4,733	8
6-----	31,217	12	10,114	20	2,315	4
7-----	13,452	5	3,267	6	2,550	5
8-----	39,236	15	5,891	12	23,550	43
9-----	15,831	6	3,823	8	7,500	14
10-----	1,424	0	(214)	(1)	428	1
11-----	45,178	17	3,029	6	3,768	7
12-----	2,094	1	22	0	1,166	2
Total	266,290	100	50,496	100	54,910	100

Figures in parentheses are increases.

Thus, we find that only five industrial groups were responsible for 74 percent of the decline in total industrial sales, the miscellaneous category accounting for the largest percentage. In like manner, five groups accounted for 72 percent of the loss in productive hours, with the machinery and tools industry contributing the greatest share. In this factor, however, shipbuilding replaces the miscellaneous industries as one of the important groups. In kilowatt-hours of electric power consumption, two industries alone accounted for 57 percent of the total decline, the metals production industry being by far the most important in this factor. The only other significant decrease was registered in the chemicals industry. It will be remembered that these two groups suffered primarily from shortages of raw materials. It is of interest to note that the five groups accounting

for 74 percent of the decline in yen sales during the raid months were also responsible for 71 percent of yen sales during the pre-raid period; therefore, the causes of decline in these groups would be indicative of the reasons for the decrease in industry as a whole. We find, then, that labor difficulties, that is, absenteeism and some shortages of skilled workers, constituted the chief obstacle to production in each of the groups, with a shortage of raw materials and fuel as second and third causes. Bomb damage contributed to the decline in both the miscellaneous and aircraft industries, with dispersal in the latter adding to the difficulties in production.

Factor Ratios in Individual Industries. In order to better understand the difficulties and requirements of production in the various industrial groups, it is necessary to apply the ratios mentioned in the paragraph on Ratio of Production Factors. We find that in four of the five major groups there was a serious decline in yen sales per productive hour. Machinery and tools, however, actually showed an increase of 43 percent in this factor, and an increase of 92 percent in kilowatt-hours per productive hours. This exception is accounted for by the fact that there was no critical shortage of skilled workers in this industry, which had sufficient component parts to continue assemblies at a high rate per hour, even though its total output dropped 58 percent because of absenteeism. The increase of 132 percent in kilowatt-hours per productive hour in basic metals production is not surprising, for unskilled labor could be used to operate the furnaces and output per kilowatt-hours actually increased in spite of a decline in

yen sales per productive hour. Table 22 shows the ratios for both the base period and the month of July 1945, together with the percentages of decrease or increase.

Production Losses Due to Bomb Damage. In order to isolate the direct effects of air attacks (bomb damage to plant and equipment) from the indirect effects (absenteeism, worker morale, etc.) and general wartime conditions (shortages of raw materials, obsolescence of machinery, etc.), it is necessary to compare the decline in production factors of damaged plants with that of undamaged plants (Graphs 13 and 14). Table 23 compares the figures for the preraid period with those of July 1945, and shows the percentages of decline during the raid months.

Thus, the ratio of loss of damaged plants to that of undamaged plants is 70 to 47, or 1.5 to 1.0 for Yen sales, 2.5 to 1.0 for productive hours, and 1.7 to 1.0 for electric power consumption. Assuming that production in all plants, both damaged and undamaged, was influenced equally by prevailing economic conditions, including the indirect effects of air attacks, we find that the decline in yen sales due to such causes would amount to 47 percent, as shown in the undamaged category. This same percentage would also hold true for the damaged

plants; therefore, any loss in excess of the 47 percent in the damaged category can be attributed to the direct effects of bombing. As the decrease in yen sales of damaged plants was 70 percent, the difference between the losses in the two categories, or 23 percent, represents the loss due to these direct effects, that is, the destruction of plant and equipment. We find, then, that in plants actually hit during air attacks, the ratio of direct bomb-damage loss to that from all other causes would be 23 to 47, or 1.0 to 2.0 for yen sales, 1.5 to 1.0 for productive hours, and 1.0 to 1.4 for electric power consumption. In order to find the production loss due to bomb damage for the entire plant sample, we again assume that, of the total decline in yen sales of 66 percent, 47 percent was due to general wartime conditions, including the *indirect* effects of air attacks. The difference of 19 percent in these two percentages would then represent the proportion of loss due to the *direct* effects, or bomb damage. Therefore, the ratio of bomb-damage loss to that from all other causes would be 19 to 47, or 1.0 : 2.5 for yen sales, 1.2 : 1.0 for productive hours, and 1.0 : 1.7 for electric power consumption. From this analysis it may be concluded that, all other factors being equal, direct hits on industrial plants increase by about 50 percent the losses

TABLE 22.—*Decline in industrial ratios*

Industry	Yen sales per productive hour			Yen sales per kilowatt-hour			Kilowatt-hours per productive hour		
	Base	July 1945	Loss Percent	Base	July 1945	Loss Percent	Base	July 1945	Loss Percent
1	4.77	1.53	68	9.58	5.01	48	0.50	0.30	40
2	1.90	2.12	(12)	7.66	11.73	(53)	.25	.18	28
3	2.63	3.65	(39)	7.19	7.68	(7)	.37	.48	(30)
4	2.92	.99	(66)	5.34	3.22	40	.55	.31	44
5	4.71	3.68	22	8.74	8.01	8	.54	.46	15
6	3.75	5.35	(43)	10.35	7.75	25	.36	.69	(92)
7	3.16	2.25	29	6.10	8.34	(37)	.52	.27	48
8	5.09	3.81	25	1.87	2.22	(21)	.73	1.69	(132)
9	3.32	2.71	18	2.44	2.96	(21)	1.36	.91	33
10	5.52	.18	97	2.87	.93	68	1.91	.20	90
11	7.73	2.84	63	6.38	2.40	62	1.21	1.18	2
12	2.55	12.13	(376)	1.50	1.20	20	1.70	10.14	(496)
Total industry	4.17	2.98	29	4.48	3.98	11	.93	.75	19

Figures in parenthesis indicate increases.

TABLE 23.—*Decline in production factors—Damaged and undamaged plants*
[Units in 1,000's]

Category	Yen sales			Productive hours			Kilowatt-hour consumption		
	Base	July	Percent	Base	July	Percent	Base	July	Percent
Damaged	327,534	229,479	70	75,973	45,476	60	73,502	48,462	66
Undamaged	78,860	36,819	47	21,596	5,021	23	16,652	6,287	38
Total	406,394	266,298	66	97,569	50,497	52	90,154	54,749	61

in production caused indirectly by air raids and other wartime conditions. If, however, we could include the plants completely destroyed by bombing (which are not represented in the sample), the proportion of loss due to air attacks would be greatly increased, as is shown by the following figures comparing the decline in industrial factors for the urban complex with that of the sample:

	Yen sales	Labor force	Productive hours
	Percent	Percent	Percent
Complex-----	74	55	85
Plant sample-----	66	17	52

NOTE.—The decline in electric power consumption for the complex, as reported by the utilities company, was only 56 percent. It is evident from the other factors, however, that the complex as a whole must have suffered a much greater loss than the sample plants.

Aircraft (Graph 15). The yen value of deliveries in this industry fluctuated greatly from month to month. Labor difficulties and changes in the model of end products contributed to the erratic nature of production during the preraid months. Reference to the electric power consumption indicates that production began its steady and precipitous decline after November 1944 and, except for a temporary recovery in April 1945, continued its downward trend until the end of the war. It is curious to note that this momentary check in the decline occurred precisely in the month of heaviest precision attacks on the industry. Of the total drop in production during the raid period (81 percent of electric power consumption by July 1945), the sharpest decline occurred in January 1945, when kilowatt-hours decreased more than 24 percent. Yen value of deliveries suffered its greatest drop in April (23 percent out of total of 85 percent). The Nakajima plants, which dominated the aircraft industry with their 37,500 workers, stressed absenteeism, lack of skilled workers, dispersal, and bomb damage, in that order, as the chief causes of the decline in production, although these installations had been continuous targets for precision attacks since February 1945.

Ordnance (Graph 16). The peak in ordnance production came at the end of 1944, with electric power consumption first falling below the base period average in February 1945. After April, the sharp decline was arrested, permitting end product deliveries to rise from 55 percent to 70 percent of normal during the remaining of the

war. The labor force remained fairly constant at around 95 percent of the base period, after a precipitous drop in March. Prior to air attacks, shortages of raw materials had played the predominant role in production declines, with labor taking a secondary part. During the raid period, however, the chief shortage was fuel, while production was further curtailed through a reduced supply of component parts. Labor difficulties were cited only as a third cause of the decline. Thus, air attacks seem to have had a negligible effect on the production of ordnance, and even their indirect effects, though labor, were only of tertiary importance.

Shipbuilding (Graph 17). Production of ships was extremely erratic during the entire period under survey. Deliveries were on the increase until August 1944 and continued at a high level until the end of the year. Electric power consumption and labor were fairly constant during the pre-raid months, though the former showed continuous light fluctuations from a steady trend. During this period, the main complaint of the industry was absenteeism, with some shortages of qualified workers, and further slowdowns due to changes in government requirements. Once the raid began, however, the labor problem ceased to be a critical factor, and the ensuing decline in production was attributable primarily to a shortage of raw materials, with customer demands for changes adding to the difficulties of production. By July 1945, both deliveries and electric power consumption had dropped more than 55 percent, while the labor force had decreased only 31 percent.

Motor Vehicles (Graph 18). Labor was at all times the primary cause of reduced production in this industry, with government orders effecting changes in end products and shortages of fuel following in that order. Here again, production was maintained at a fairly constant level until November 1944, with deliveries producing the usual erratic fluctuations. The labor force remained above the preraid average until June 1945, but electric power consumption had already begun to fall off in December 1944. The decline in the latter factor was gradual until April 1945, with a precipitous drop thereafter, bringing the total loss to 65 percent by July. Deliveries in the meantime had fallen 79 percent, while the labor force was reduced only 9 percent. The decline in the pro-

duction of motor vehicles was due to absenteeism and shortages of skilled workers.

Electrical Products (Graph 19). Deliveries in this industry reached their peak in December 1944, held above normal until March 1945, then began an almost vertical drop to June, leveling off during the last 2 months of the war with a loss of 64 percent. Electric power consumption fluctuated only slightly until February 1945, when it began to decline sharply. In April the drop was precipitous, but by June it had leveled off with deliveries, finishing the last 2 months with a total decline of 60 percent. During the preraid months, the shortage of raw materials was the most important factor limiting higher production and labor was a secondary problem; but after the air attacks had begun, absenteeism and some lack of skilled workers became primary cause of the decline, in spite of the fact that the total labor force had diminished only 10 percent by July. The shortage of raw materials continued, however, as a secondary cause, followed by a shortage of fuel.

Machinery and Tools (Graph 20). The erratic fluctuations in this industry during the pre-raid months were attributable to shortages of raw materials and government orders effecting changes in end products. Peak deliveries were reached in November 1944, with maximum electric power consumption occurring at the same time. Though production fell off slightly in January 1945, the real decline did not set in until March of that year. In May, the drop in both electric power consumption and deliveries was slowed down, ending in July with losses of 45 percent and 58 percent, respectively. The labor force in the meantime had decreased only 20 percent. Absenteeism was cited as the main cause of the decline in production during the raid period, with shortages of raw materials and fuel as second and third causes.

Metal Products (Graph 21). After an erratic preraid production ascribed to labor difficulties and official orders effecting changes in end production, this industry reached its peak of deliveries in October 1944; thereafter the decline was rapid. Electric power consumption, on the other hand, attained its peak as early as December 1943, with the final decline beginning just 1 year later. Thereafter, the two factors showed a parallel decline, yen sales dropping 68 percent and Kwh

74 percent by June 1945; though both registered slight rises in July. The labor force had decreased only 18 percent at the end of the raid period; but absenteeism was still cited as the main cause of the decline in production. Shortages of raw materials were secondary.

Basic Metal Production (Graph 22). During the entire period under survey, the causes given for difficulties in the production of basic metals were, in order of importance, labor, fuel and raw materials. The decline in both deliveries and electric power consumption began in December 1944, continued gradually until March 1945, then dropped sharply in April. After a temporary check in the downward trend in May and June, the gradual decline was resumed, yen sales ending in July with a loss of 59 percent and electric power consumption declining 66 percent. The labor force had diminished only 5 percent during the same period.

Chemicals (Graph 23). In this industry, raw materials and fuel were at all times critically short. For this reason, production was fairly steady, with no extreme peaks or troughs during the pre-raid period. A gradual decline in all factors set in after November 1944, electric power consumption decreasing 61 percent and yen sales 56 percent by June 1945. The labor force had risen 4 percent by the same month.

Petroleum (Graph 24). As the raw materials for this industry had to be imported, critical shortages existed in this factor throughout the war. Labor difficulties were a secondary cause of the erratic fluctuations occurring throughout the pre-raid months, while dispersal played an important part in the decline during the period of air raids. Finally, in June and July 1945, precision attacks further reduced oil production in the area, though physical damage occurred too late in the war to permit an attempt at recovery. The labor force increased steadily until July 1945, ending that month at 236 percent of the preraid average. The downward trend in both yen sales and electric power consumption began in November 1944, and though fluctuation in both factors continued to be extremely erratic, deliveries registered a total decline of 94 percent and kwh a drop of 82 percent by July 1945.

Miscellaneous Industries (Graph 25). Labor difficulties were the chief cause of production decline in the leather, textiles and paper industries, part of whose output was intended for civil-

ian consumption. Official orders requiring production changes were also responsible for fluctuations during the pre-raid months, while fuel played a secondary part during the period of air raids. Damage due to air attacks had a serious effect on production, as many of the plants in this category were situated in the bombed areas of the cities. The decline in production began after the October 1944 peak, deliveries dropping 78 percent and electric power consumption 42 percent by July 1945. The labor force decreased only 21 percent over the same period.

Public Utilities (Graph 26). Gas plants suf-

fered continuous shortages of the prime raw material coal, at all times. Deliveries continued fairly steady through December 1944, after which month they began a gradual decline. In April 1945, sales dropped sharply, but steadied during the following months, ending in July with a loss of 60 percent. Electric power consumption in this industry began its downward trend only in March 1945, reaching 50 percent of its pre-raid average by the end of the war. The labor force had increased somewhat during this period. (The other two utilities, electric power and water, are not included in this study.)

EFFECTS OF BOMBING ON INDUSTRIAL TOKYO

Introduction. As the industrial statistics for Tokyo are more complete and in greater detail than those for the complex as a whole, especially in the matter of physical damage, an analysis of the decline in production in this one city gives a clearer picture of the industrial activity of the entire urban area under survey. According to the Japanese national census of February 1944, Tokyo accounted for 85 percent of the industrial workers, 80 percent of the industrial buildings, and 84 percent of the industrial building area in the three cities. It likewise consumed 68 percent of the electric power and 72 percent of the gas used by industry in the complex. It is significant that the capital, depending to a great extent on small shops employing a large proportion of hand workers, required only 27 percent of the coal and 40 percent of the coke consumed by plants in the area. Of the 516 plants sampled for the over-all analysis, Tokyo's 337 accounted for 58 percent of the yen sales, 54 percent of the productive labor hours, 50 percent of the labor force, and 37 percent of the electric power consumption. Thus, Tokyo itself represents a fair sample of industrial activity in the complex as a whole, while its great variety of industries and the wide range of its plant sizes lend additional validity to the analysis.

Industrial Plants Prior to Air Attacks. The total number of plants in Tokyo in 1940 was 91,370, the workers numbering 728,092. The process of amalgamation and combing out of smaller installations, and the resultant shift of workers to larger plants, had reduced the total number of plants to 98 percent of the above figure by 1942, and to 45 percent by October 1944, just prior to the first air attack. The number of workers, on the other hand, had increased to 106 percent and 151 percent during the same periods. The changes in number of plants and workers, by size of installation, together with the percentage loss or gain from 1942 to October 1944, are shown in Table 24. The over-all increase in labor force came about chiefly through the closing of wholesale and retail establishments and the transfer of their employees (over 800,000 in 1940) to factory work. By October 1944, there were only 190,000 persons engaged in trade. Category 2 shows the major gain in number of both plants and workers, some of the increase having been acquired from Category 1.

TABLE 24.—*Number of plants and workers prior to raids*

Number of workers	1940	1942	October 1944	Percent of increase or (decrease)
Category 1, (1 to 9) :				
Plants.....	81,048	79,793	23,963	(70)
Workers.....	239,469	217,058	81,518	(66)
Category 2, (10 to 49) :				
Plants.....	8,609	8,410	15,759	83
Workers.....	177,351	168,173	510,624	188
Category 3, (50 to 99) :				
Plants.....	939	905	919	(2)
Workers.....	63,862	61,511	70,419	10
Category 4, (100 and over) :				
Plants.....	774	765	907	17
Workers.....	247,410	322,696	438,946	77
Total :				
Plants.....	91,370	89,873	41,548	(55)
Workers.....	728,092	769,438	1,101,507	51

Source: National Census.
Figures in parenthesis are increases.

Plant Loses During the Raid Period. By August 1945, the total number of plants operating in Tokyo had been reduced to 13,193, or 32 percent of the October 1944 figure, while the number of industrial workers had declined to 596,364, or 54 percent. Table 25 shows the decrease in each category during the raid period. Category 2, which had registered the greatest increase prior to air attacks, suffered the sharpest drop during the months of air attacks. Plants in the first two categories were located for the most part in the more densely populated sections of the city and were thus highly vulnerable to the incendiary raids which desolated those areas: but the larger plants, situated in the more sparsely settled suburbs, generally escaped major damage. In all, over 25,000 plants were destroyed or badly damaged, affecting more than half a million workers.

Importance of Small Plants. It was impossible to obtain a valid sample of small plants (under 100 workers), for the simple reason that most of them had been destroyed in the devastating area raids of the spring of 1945. However, the importance of this category prior to air attacks, and the effect which their destruction exercised on the industrial production of Tokyo, is evident from the figures shown in Tables 24 and 25. In 1940,

TABLE 25.—*Decrease in number of plants and workers during raids*

Number of workers	October 1944	August 1945	Percent of decrease
Category 1 (1 to 9) :			
Plants_____	23,963	8,408	65
Workers_____	81,518	35,781	56
Category 2 (10 to 49) :			
Plants_____	15,759	3,309	79
Workers_____	510,624	83,082	84
Category 3 (50 to 99) :			
Plants_____	919	668	27
Workers_____	70,419	58,125	17
Category 4 (100 and over) :			
Plants_____	907	808	11
Workers_____	438,946	419,376	4
Total :			
Plants_____	41,548	13,193	68
Workers_____	1,101,507	596,364	46

Source: Welfare Ministry.

these smaller plants accounted for 52 percent of the total industrial output of the city (4,587 million yen), and in 1942 for 53 percent of a total of 6,019 million yen. In the same years their total labor force amounted to 66 percent and 58 percent, respectively. In October 1944, the labor force of these small plants represented 60 percent of the city's total, and it is logical to assume that their combined production would have been between 50 and 55 percent of the total at that time. Referring to Table 25, we find that in industries employing under 100 workers, 28,256 out of a total of 40,641 plants had ceased operation by July 1945, and that the number of workers in this group had dropped from 662,561 to 176,988, a loss of 73 percent. On the basis of small plant production for 1940 and 1942, therefore, we may assume that bomb damage resulted in a production loss of approximately 75 percent. As this category accounted for about half the production of the entire city, the decline actually represented an industrial loss of around 37 percent for Tokyo. Therefore, the Tokyo plant sample, which contains only those plants employing over 100 workers, is representative of only half of the city's industrial activities. Table 26 compares the two categories of plants and shows the percentage of decline, in terms of labor force, during the raid period.

Value of Plant Sample. The sampled plants in Tokyo accounted for 19 percent each of the total labor force and productive hours and 20 percent of the industrial electric power consumption in the

TABLE 26.—*Decline in workers during raid period*

Category	Workers				Percent loss
	October 1944	Percent	July 1945	Percent	
Under 100 workers	662,561	60	176,988	30	73
Over 100 workers	438,946	40	419,376	70	4
Total_____	1,101,507	100	596,364	100	46

Source: Welfare Ministry.

city prior to the period of air attacks. If, however, we consider only that portion of the city's industries represented by the sample (plants employing over 100 workers), we find that the reporting plants would actually account for 53 percent of the labor force and a corresponding proportion of the Yen output and electric power consumption in this category. (While 37 out of the 337 sampled plants reported fewer than 100 workers, their combined production represents only one percent of the total sample. As these small industries have already been covered in this report, this small percentage may be ignored in subsequent analyses.) In order to afford a better cross section of Tokyo industries, the sampled plants have been arranged according to two classifications: (1) by industrial category and (2) by labor group, that is, by size of plant. The ratios of industrial factors have been worked out on both bases. Throughout this study, therefore, the plants are grouped according to the following lists.

Number		Number of plants
	<i>By industry</i>	
1_____	Aircraft and alternating-current engines	9
2_____	Ordnance	19
3_____	Shipbuilding	7
4_____	Motor vehicles	9
5_____	Electrical products	40
6_____	Machinery and tools	60
7_____	Metals products	52
8_____	Basic metals	51
9_____	Chemicals	36
10_____	Miscellaneous (textiles, etc.)	54
	Total_____	337
	<i>By labor group</i>	
1_____	Under 100 workers	37
2_____	100 to 250 workers	127
3_____	250 to 500 workers	68
4_____	500 to 1000 workers	62
5_____	1000 to 2500 workers	27
6_____	2500 to 5000 workers	12
7_____	Over 5000 workers	4
	Total_____	337

Over-all Production Trends (Graph 27). A sales peak of 296.2 million yen was reached in

October 1944, and it was not until January 1945 that deliveries dropped below the monthly average for the pre-raid period. At the end of April, the sharp decline was arrested somewhat and sales even rose slightly in June, but in July the total decline had reached 65 percent. Electric power consumption continued at a fairly steady level through November 1944, then declined gradually until February 1945, and fell off sharply the following month. The downward trend in this factor was also checked momentarily in April, but continued thereafter, registering a total drop of 54 percent by July. Productive labor hours began to decrease slightly in November 1944, but did not drop below the pre-raid average until February 1945. In spite of an accelerated decline in April, productive hours rose temporarily in May, only to fall again thereafter, showing a loss of 49 percent by July. The labor force was normal until May 1945, and had lost only 19 percent by the end of the war. Evidence of the drastic effects of the area raids is seen in the precipitous drop in all factors during March and April.

Decline in Production Ratios. At the end of the raid period, yen sales per worker had decreased 57 percent, and productive hours per worker had dropped 37 percent. Thus, not only was the productivity of active labor reduced; inactive labor had greatly increased and absenteeism had become the most serious factor in the labor problem. The fact that sales per productive hour had also fallen off 32 percent indicates a growing inefficiency on the part of workers. This is further borne out by the decline in sales per kilowatt-hour, of 24 percent evidence that machine efficiency was reduced because of the employment of untrained workers. Kilowatt-hours per worker had dropped 43 percent and kilowatt-hours per productive hour 11 percent during the raid months.

Decline in Individual Industries. Table 27 shows the average monthly figures of each production factor in each industry for the pre-raid period, October 1943 through September 1944, and the figures for July 1945, together with the percentage relationship which each industry bears to the total and the percentage of decline or loss during the raid period. We find that the predominant industries during the base or pre-raid period were aircraft, machinery and tools, basic metals, and miscellaneous, these four categories alone accounting for 68 percent of yen sales. The greatest losses occurred in the aircraft and miscellaneous

industries, with shipbuilding, electrical products, and metal products each registering the next highest losses. Monthly fluctuations in each industry may be seen on Graphs 28 to 37. The most erratic activities are found in the aircraft and shipbuilding industries, while the motor vehicle industry proved to be the steadiest. Production in almost every industry had dropped below the base period by the end of 1944, but the production level in ordnance and electrical products was maintained until March 1945. Aircraft registered the most precipitous drop prior to the heavy area raids, production falling from 58.4 million yen in October 1944 to 19.4 million in February 1945, a loss of 67 percent in 4 months. The miscellaneous industries (textiles, leather, paper, etc.) also showed a marked decline prior to the incendiary attacks, production dropping from 55.5 million Yen in October 1944 to 19.0 million in January 1945, a loss of 66 percent in 3 months. Of the 10 industrial groups, all except aircraft, shipbuilding and the miscellaneous industries registered their sharpest decline during the months of heavy incendiary raids on Tokyo. Table 28 compares the decline in each industry with the total decline for all industries. Here it is seen that the four groups accounting for 68 percent of the yen sales during the pre-raid period were also responsible for 75 percent of the loss during the months of air attacks.

Decline in Production Ratios of Individual Industries. Table 29 shows the decrease in production ratios in each industry, in both absolute figures and percentages. In all sales ratios, aircraft and the miscellaneous industries showed the greatest drops, while the other two major groups, machinery and tools and basic metals, closely paralleled the average decline for industry as a whole. In the last mentioned group, sales per kilowatt-hour actually increased during the raid period which indicated a more efficient use of electric power, and although there was also a decline in kilowatt-hours per productive hour this industry had less need of skilled workers than did the others. Examination of the figures shows that in almost every case the loss of production was due (1) to absenteeism (decrease in productive hours per worker) and (2) loss of efficiency among the productive workers (decrease in sales per productive hour); and at least a portion of that inefficiency is due to a lack of skilled labor.

TABLE 27.—*Decline in production factors, by industry*
[All units in 1000's, except Labor Force]

Industry	Yen sales					Kilowatt-hours					Labor force					Productive hours				
	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss
1	41,914	18	4,980	6	88	4,725	14	1,267	8	73	37,553	17	23,648	13	27	7,961	15	2,889	11	64
2	6,760	3	5,041	6	25	932	3	454	3	51	15,138	7	13,565	8	10	3,995	8	2,475	9	38
3	7,175	3	2,224	3	69	952	3	387	2	59	15,916	7	9,781	5	38	3,573	7	964	4	73
4	14,277	6	12,083	15	15	825	2	416	3	50	13,462	6	12,119	7	10	3,040	6	1,839	7	39
5	18,565	8	5,674	7	69	925	3	411	3	56	22,629	10	18,800	10	17	4,450	8	1,851	7	58
6	45,309	19	17,729	21	61	4,019	12	2,130	14	47	46,833	21	36,285	20	22	12,153	23	6,527	24	46
7	9,986	4	3,113	4	69	1,272	4	340	2	73	13,496	6	12,462	7	7	3,092	6	1,666	6	46
8	27,660	12	12,438	15	55	11,152	33	4,214	27	62	21,881	10	19,345	11	12	5,243	10	3,074	11	41
9	18,527	8	11,416	14	38	4,013	12	2,705	18	33	14,605	6	17,218	9	(18)	3,270	6	2,434	9	26
10	45,636	19	7,225	9	84	4,669	14	3,109	20	33	23,554	10	18,762	10	20	5,937	11	3,409	12	43
Total	235,809	100	81,923	100	65	33,484	100	15,433	100	54	225,067	100	181,986	100	19	52,714	100	27,128	100	49

NOTE.—Figure in parenthesis indicates increase.

TABLE 28.—*Comparative decline in production factors, by industry*
[All units in 1000's, except Labor Force]

Industry	Yen sales		Kilowatt-hours		Labor force		Productive hours	
	Decline	Percent	Decline	Percent	Decline	Percent	Decline	Percent
1	36,934	24	3,458	19	13,905	32	5,072	20
2	1,719	1	478	3	1,573	4	1,520	6
3	4,951	3	565	3	6,135	14	2,609	10
4	2,194	1	409	2	1,343	3	1,201	5
5	12,891	8	514	3	3,829	9	2,599	10
6	27,580	18	1,889	10	10,547	25	5,625	22
7	6,873	5	932	5	1,034	2	1,426	6
8	15,222	10	6,938	39	2,536	6	2,169	8
9	7,111	5	1,308	7	(2,613)	(6)	836	3
10	38,411	25	1,560	9	4,792	11	2,528	10
Total	153,886	100	18,051	100	43,081	100	25,586	100

Figures in parentheses are increase.

TABLE 29.—*Decline in production ratios, by industry*

Ind.	Yen sales									Productive hours per worker			Kilowatt-hours					
	per worker			per productive hour			per kilowatt-hour			Base	July	Loss	per worker			per productive hour		
	Base	July	Loss	Base	July	Loss	Base	July	Loss				Base	July	Loss	Base	July	Loss
1	1,116	211	81	5.26	1.72	67	8.90	3.90	56	212	122	42	126	54	58	0.59	0.44	25
2	451	372	17	1.69	2.04	(21)	7.30	11.10	(52)	263	182	31	62	33	47	0.23	0.18	22
3	447	227	50	2.01	2.31	(15)	7.50	5.70	24	225	99	56	60	40	33	0.27	0.40	(48)
4	1,061	997	6	4.70	6.57	(40)	17.30	29.10	(68)	226	152	33	61	34	44	0.27	0.23	15
5	820	302	63	4.17	3.07	26	20.10	13.8	31	197	98	50	41	22	46	0.21	0.22	(4)
6	967	488	50	3.73	2.71	27	11.30	8.30	27	260	180	31	86	59	31	0.30	0.33	(10)
7	740	260	65	3.23	1.87	42	7.90	9.20	(16)	229	134	41	94	27	71	0.41	0.20	51
8	1,264	643	49	5.27	4.05	23	2.40	3.00	(25)	240	159	34	510	218	57	2.13	1.37	36
9	1,269	663	48	5.67	4.69	17	4.60	4.20	9	224	141	37	272	157	42	1.23	1.11	10
10	1,937	385	80	7.68	2.12	72	9.70	2.30	76	252	182	28	198	166	16	0.79	0.91	(15)
Total Industry	1,048	459	57	4.47	3.02	32	7.00	5.39	24	235	149	37	149	85	43	0.61	0.57	11

Figures in parentheses are increase.

Decline in Individual Labor Groups. Table 30 shows the average monthly figures for each production factor in each labor group during the pre-raid period and the figures for July 1945, together with the percentage relationship which each group bears to industry as a whole and the percentage of decline or loss during the raid period. We find here that the larger groups have the larger labor forces and are responsible for the greater production prior to the period of air attacks; although Group 2 (100 to 250 workers) shows a relatively high rate of sales. The high percentage of electric power consumption in Group 4 (500 to 1,000 workers) is accounted for by the fact that it contains most of the basic metals production industry, the main industrial user of electricity. Group 6 (2,500 to 5,000 workers) showed the greatest decline in all production factors, while Group 4 actually registered an increase in number of workers. This latter phenomenon is attributable to the chemicals industry, which had almost doubled its labor force in this group by the end of the war. Production in all groups began to decline between October 1944 and January 1945, the

larger groups beginning later than the smaller. The most erratic was Group 7 (over 5,000 workers), which contained the largest aircraft plants and shipbuilding yards. The steadiest production trend is found in Group 4, a large proportion of which was the basic metals production industry. Except for Groups 2 and 7, major declines occurred during the months of heaviest area raids on the city. Table 31 compares the decline in each labor group with the decline for industry as a whole. Here it is seen that the two largest groups account for the greatest proportion of the decline in all factors except electric power consumption, and in this, Group 4 contributes the greatest share. These same groups also registered the highest percentages of the same factors during the pre-raid period. It is of significance that the extent of decline in production factors bore no relationship to the size of the plants; and it may be concluded that the indirect effects of air attacks and the influence of the disintegrating wartime economy of the city were felt equally by all plants regardless of size.

Decline in Production Ratios of Labor Groups. Table 32 shows the decrease in production ratios in

TABLE 30.—*Decline in production factors, by labor group*
[All units in 1000's, except Labor Force]

Group	Yen sales					Kilowatt-hours					Labor force					Productive hours				
	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss	Base	Percent	July	Percent	Percent of loss
1	3,506	2	3,021	4	14	210	1	187	1	11	2,971	1	2,806	2	6	794	1	601	2	24
2	42,589	18	10,792	13	75	3,940	12	1,656	11	58	20,100	9	17,203	9	14	4,841	9	2,920	11	40
3	25,730	11	9,921	12	61	5,944	18	2,366	15	60	21,565	10	19,908	11	8	4,889	9	2,812	10	42
4	29,301	12	19,055	23	35	10,615	32	5,841	38	45	35,481	16	37,332	20	(5)	8,377	16	5,292	20	37
5	33,458	14	10,988	13	67	3,177	9	1,656	11	48	36,578	16	30,260	17	17	8,969	17	6,104	22	32
6	44,645	19	8,148	10	82	2,149	6	766	5	64	47,807	21	33,920	19	29	10,306	20	3,238	12	69
7	56,579	24	19,999	25	65	7,449	22	2,961	19	60	60,565	27	40,557	22	33	14,538	28	6,160	23	58
Total	235,809	100	81,924	100	65	33,484	100	15,133	100	54	225,067	100	181,986	100	19	52,714	100	27,127	100	49

TABLE 31.—*Comparative decline in production factors, by labor group*
[All units in 1000's, except Labor Force]

Group	Yen sales		Kilowatt-hours		Labor force		Productive hours	
	Decline	Percent	Decline	Percent	Decline	Percent	Decline	Percent
1	485	1	23	0	165	1	193	1
2	31,797	21	2,284	13	2,897	7	1,921	7
3	15,809	10	3,578	20	1,657	4	2,077	8
4	10,246	7	4,774	26	(1,851)	(5)	3,085	12
5	22,470	15	1,521	8	6,318	15	2,865	11
6	36,497	23	1,383	8	13,887	32	7,068	28
7	36,580	23	4,488	25	20,008	46	8,378	33
Total	153,884	100	18,051	100	43,081	100	25,587	100

NOTE. Figure in parenthesis indicates increase.

TABLE 32.—*Decline in production ratios, by labor group*

Group	Yen sales									Productive hours per worker			Kilowatt hours					
	Per worker			Per productive hour			Per kilowatt-hour						Per worker			Per productive hour		
	Base	July	Loss	Base	July	Loss	Base	July	Loss	Base	July	Loss	Base	July	Loss	Base	July	Loss
			Per- cent			Per- cent			Per- cent			Per- cent			Per- cent			Per- cent
1	1,180	1,077	9	4.41	5.02	(14)	16.70	16.20	3	267	214	20	71	65	8	0.26	0.31	(19)
2	2,118	627	70	8.79	3.69	58	10.80	6.50	40	241	170	29	196	96	51	0.81	0.57	30
3	1,193	498	58	5.26	3.53	33	4.30	4.20	2	227	141	38	276	118	57	1.22	0.84	31
4	826	510	38	3.50	3.60	(3)	2.80	3.30	(18)	236	142	40	299	156	48	1.27	1.10	13
5	912	363	60	3.73	1.80	52	10.50	6.60	37	245	202	18	87	55	37	0.35	0.27	23
6	934	240	74	4.33	2.52	42	20.80	10.60	49	216	95	56	45	23	49	0.21	0.24	(14)
7	934	493	47	3.89	3.24	17	7.60	6.80	11	240	152	37	123	73	41	0.51	0.48	6
Total	1,048	450	57	4.47	3.02	32	7.00	5.30	24	235	149	37	149	85	43	0.64	0.57	11

Figures in parentheses are increase.

each labor group, in both absolute figure and percentages. These ratios bear out the previous conclusion that size of plant has no direct relationship to declines. Group 4, as we have seen, showed an actual increase in labor force during the raid period. In this group we find that, despite the evidence of absenteeism, active labor became more productive (increase in sales per productive hour) and electric power was used more efficiently (increase in sales per kilowatt-hour) than during the preraid period. Group 6 suffered most from absenteeism (decrease in productive hours per worker) and consequently showed the greatest loss in productivity (decrease in sales per worker). Loss of worker efficiency was most serious in group 2 (decrease in sales per productive hour).

Damage to Plants in Sample. It will be recalled from Table 25 that the industrial group represented by this sample (plants employing over 100 workers) lost only 99 of its 907 plants and 4 percent of its labor force. Of the 337 industrial plants in the Tokyo sample, 190, representing 76 percent of the workers, were hit by bombs. Altogether, 3,626 workshops in these plants were completely destroyed, and of the undetermined number of those damaged, only 310 were restored. In 371 cases, a new building was erected on the site of the destroyed shop, and in 265 additional cases, new sites were chosen. Thus, less than 19 percent of the totally destroyed shops were rebuilt. Table 33 gives the number of workshops destroyed in each industrial group, by month. From this it appears that the most damaging raids were the two occurring in April, although the bomb tonnage for May was much greater. However, it is quite possible that the smaller plants (under 100 workers) suffered most

in the raid of 10 March, which struck the most thickly settled area in Tokyo. Most industries were fairly well dispersed throughout the city, though aircraft plants were found chiefly in the suburbs and shipbuilding yards were limited to the harbor district. The chemicals industry reported the greatest amount of destruction in almost every air attack.

Production Losses Due To Bomb Damage. The damaged plants in the sample accounted for approximately three-quarters of all production factors as shown in Table 34. Fluctuations in the damaged and undamaged plants can be seen in Graphs 38 and 39. Assuming that all plants are equally affected by general wartime conditions, as well as by the indirect effects of bombing, the difference between the decline in damaged plants and that in undamaged plants would represent the loss due to bomb damage. Therefore, as the sales decline in damaged plants during the raid period was 72 percent and in undamaged plants 33 percent, the difference, 39 percent can be attributed to the direct effects of air attacks, or bomb damage. This is true, of course, only if the same plants (all damaged) are considered. If we include also the plants undamaged by air attacks, the loss due to bombing will be found by subtracting the percentage loss of undamaged plants, not from that of damaged plants, but from the percentage loss of industry as a whole. In the case of yen sales, the total loss was 65 percent, that of undamaged plants 33 percent, and the difference, representing the loss due to bomb damage for the entire sample, 32 percent. The ratio of loss caused by bombings to that from all other causes would then be: 1 : 1 for yen sales, 2.2 : 1 for electric power consumption, 9 to 1 for labor force, and 1.2 to 1 for pro-

TABLE 33.—*Workshops destroyed in air attacks*

Industry	Plants hit	1944		1945								Total shops
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
1-----	6	7	16	7	--	3	13	16	--	--	16	78
2-----	10	--	--	--	2	16	58	18	--	--	40	134
3-----	6	4	--	--	2	125	50	--	--	--	--	181
4-----	5	--	--	--	--	20	46	10	--	--	--	76
5-----	22	4	4	--	7	10	129	203	--	--	16	373
6-----	34	--	2	--	14	69	231	277	10	--	18	621
7-----	26	--	--	4	--	142	87	88	--	--	4	325
8-----	31	--	--	--	5	150	113	77	3	--	29	377
9-----	20	2	--	5	39	210	252	252	--	--	16	776
10-----	30	--	--	24	27	69	279	31	17	--	38	485
Total-----	190	17	22	40	96	814	1,258	972	30	--	177	3,426

TABLE 34.—*Decline in production factors, by damaged and undamaged plants*
[All units in 1000's, except Labor Force]

Category	Yen sales				Percent of loss	Kilowatt-hours				Percent of loss	Labor force				Percent of loss	Productive hours				Percent of loss
	Base	Percent	July	Percent		Base	Percent	July	Percent		Base	Percent	July	Percent		Base	Percent	July	Percent	
Damaged_	195,270	83	54,815	67	72	26,310	79	9,516	62	64	172,159	76	129,733	71	25	39,570	75	16,818	62	57
Undamaged	40,539	17	27,109	33	33	7,174	21	5,916	38	18	52,907	24	52,253	29	1	13,144	25	10,309	38	22
Total_	235,809	100	81,924	100	65	33,484	100	15,432	100	54	225,066	100	181,986	100	19	52,714	100	27,127	100	49

TABLE 35.—*Comparative decline in production ratios, damaged and undamaged plants*

Category	Yen sales									Production hours			Kilowatt-hours				
	Per worker			Per production hour			Per kilowatt-hour			Per worker			Per worker		Per production hour		
	Base	July	Loss (percent)	Base	July	Loss (percent)	Base	July	Loss (percent)	Base	July	Loss (percent)	Base	July	Loss (percent)	Base	Loss (percent)
Damaged_____	1,134	422	63	4.93	3.25	34	7.42	5.75	22	230	130	43	153	73	52	0.56	0.57
Undamaged_____	766	519	32	3.08	2.63	15	5.65	4.58	19	246	197	21	136	113	17	0.55	0.57 (4)
Total_____	1,046	450	57	4.47	3.02	32	7.00	5.30	24	235	149	37	149	85	43	0.64	0.57 11

NOTE.—Figure in parenthesis indicates increase.

ductive hours. It is of further interest to compare the decline in production ratios of the two categories, as in Table 35. Taking yen sales per worker as an example, we find that the total loss for the sample comes to 57 percent. The difference between this and the loss shown by the undamaged plants (32 percent) is 25 percent, representing the loss due to bomb damage in the entire sample. In like manner, the decline attributable to bombing in yen sales per productive hour is 17 percent, in kilowatt-hours per productive hour, 5 percent in productive hours per worker, 17 percent, etc. Hence, in this efficiency and productivity series,

the ratio of decline due to bombing, as compared with that due to all other causes, is approximately one to one.

Conclusion. We have seen that small and large plants each accounted for about one-half of Tokyo's industrial output, and that the decline in yen value of their production was 75 percent and 65 percent, respectively. The total decline would therefore be 70 percent. Similarly, loss of production due to bomb damage accounted for almost all the decline, or approximately 70 percent, in the case of small plants, and 39 percent in the case of large plants; consequently, the total loss attrib-

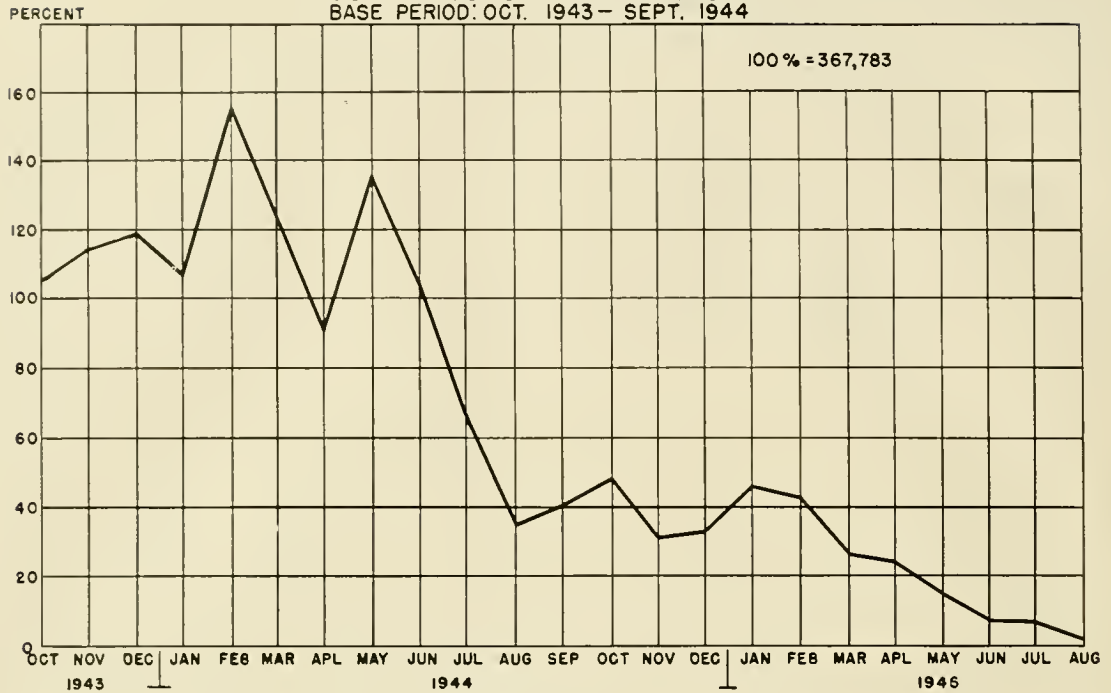
utable to the direct effects of bombing would be around 55 percent. The remaining 15 percent of the over-all decline would then be accounted for

by the indirect effects of air attacks and other war-time economic conditions.

SHIPPING—GROSS REGISTERED TONNAGE

TOKYO—YOKOHAMA—KAWASAKI

BASE PERIOD: OCT. 1943—SEPT. 1944

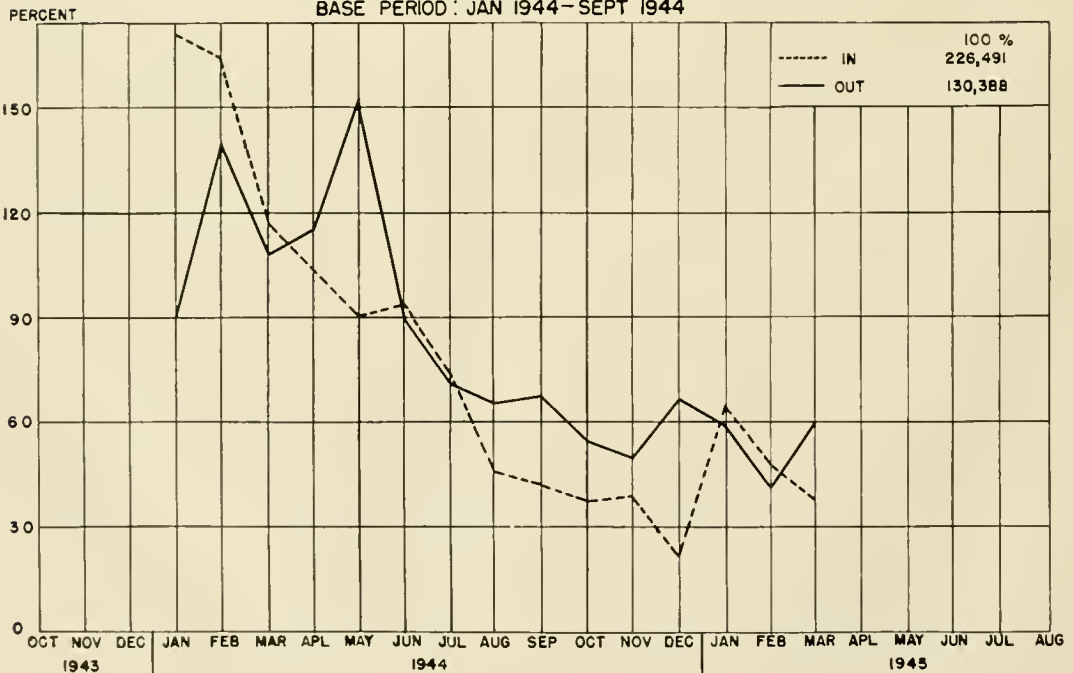


Graph 1.

SHIPPING—TOTAL IN & OUT

TOKYO—YOKOHAMA—KAWASAKI

BASE PERIOD: JAN 1944—SEPT 1944

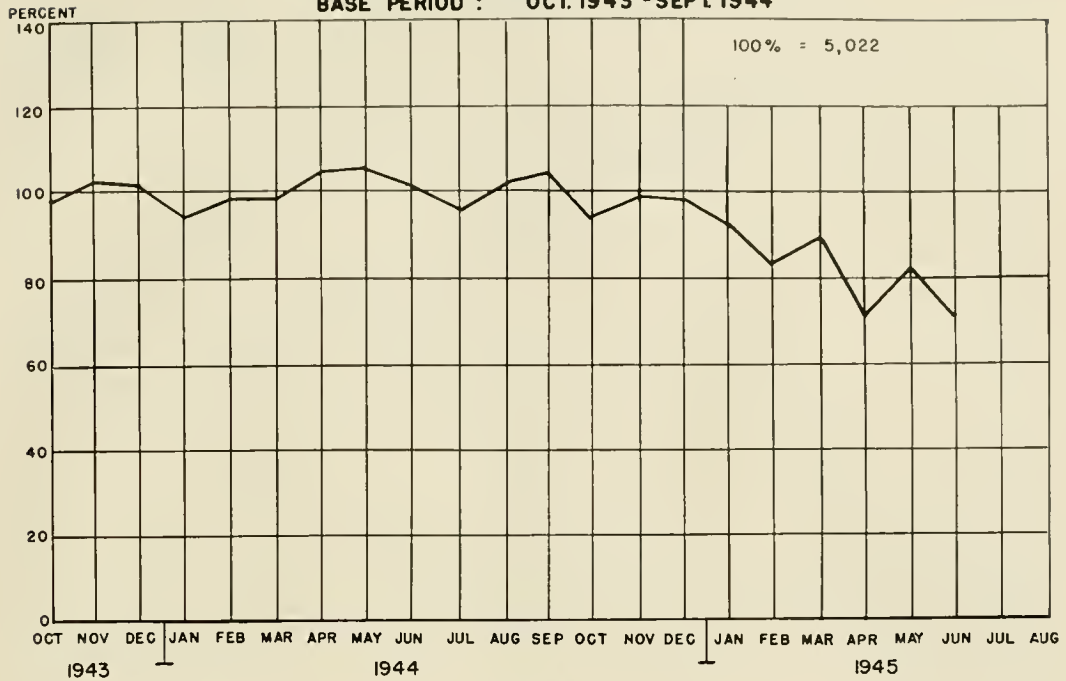


Graph 2.

AVERAGE DAILY CARLOADINGS

TOKYO DIVISION - JAPANESE GOVERNMENT RAILWAY

BASE PERIOD : OCT. 1943 - SEPT 1944

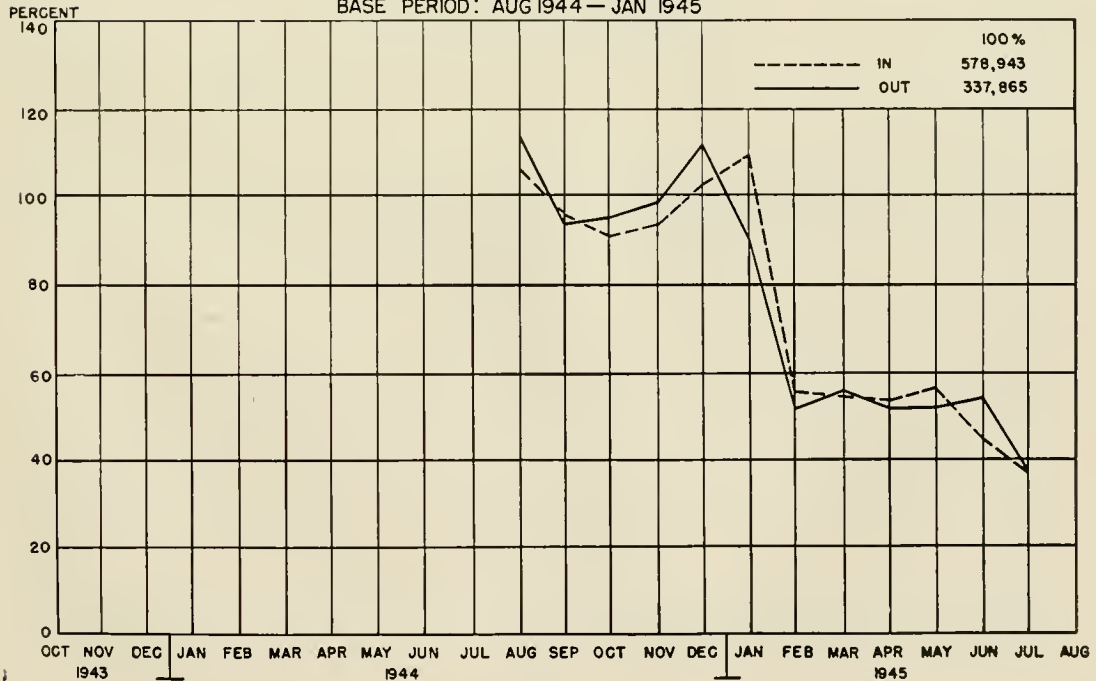


Graph 3.

TRUCKING-TOTAL IN & OUT

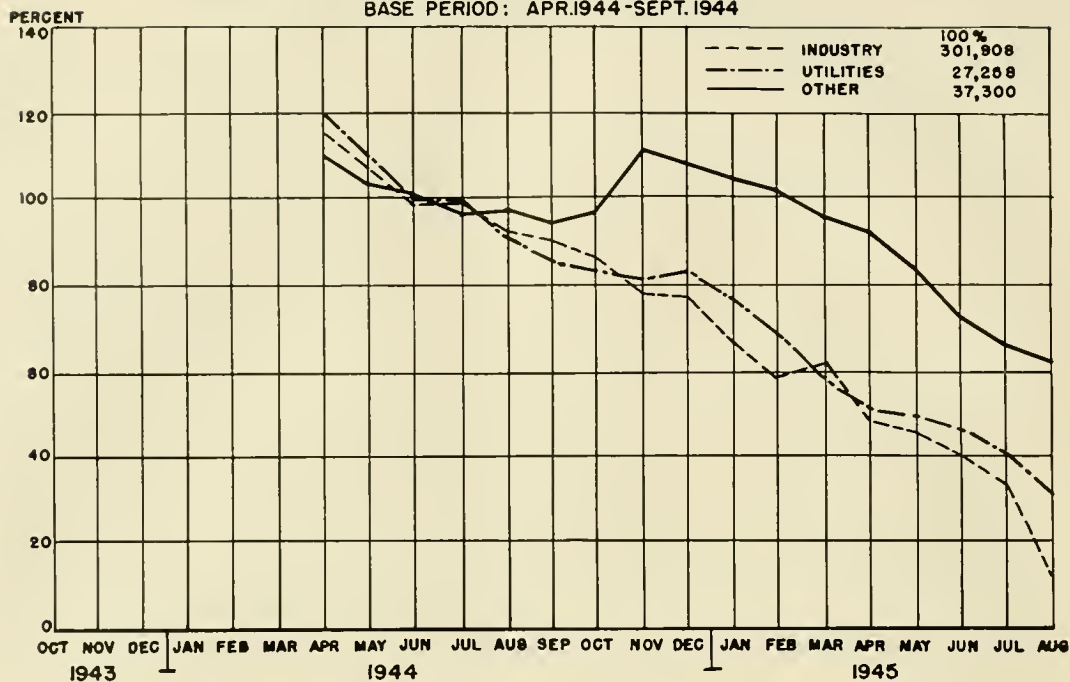
TOKYO-YOKOHAMA-KAWASAKI

BASE PERIOD: AUG 1944 - JAN 1945



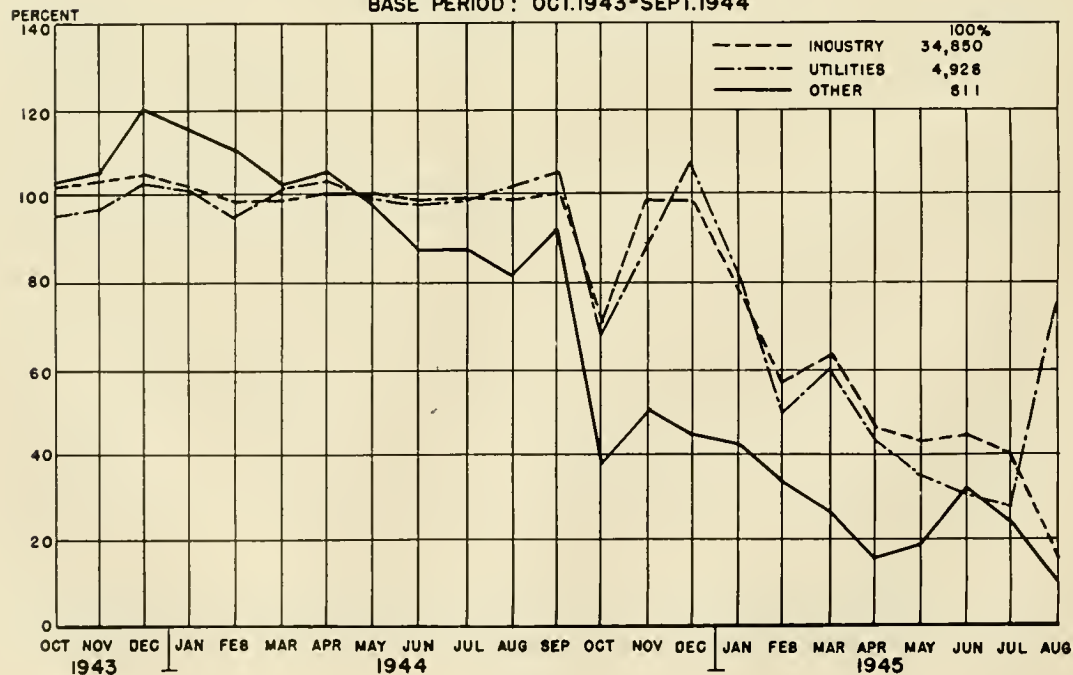
Graph 4.

COAL CONSUMPTION TOKYO - YOKOHAMA - KAWASAKI BASE PERIOD: APR.1944-SEPT.1944



Graph 5.

COKE CONSUMPTION TOKYO - YOKOHAMA - KAWASAKI BASE PERIOD: OCT.1943-SEPT.1944

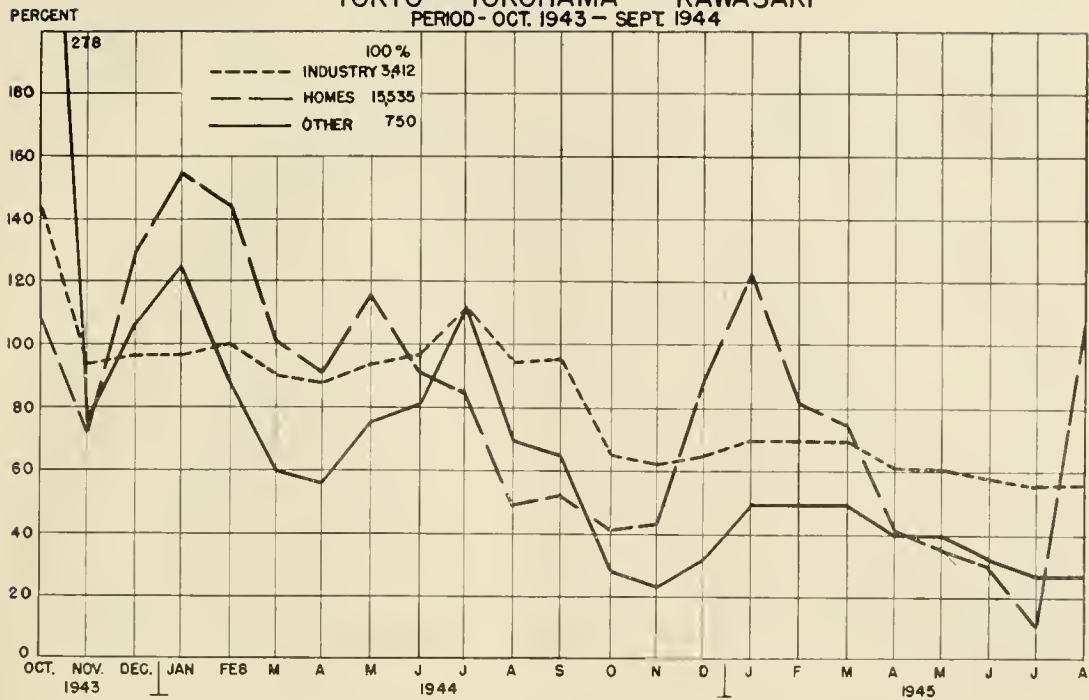


Graph 6.

CHARCOAL CONSUMPTION

TOKYO - YOKOHAMA - KAWASAKI

PERIOD - OCT. 1943 - SEPT. 1944

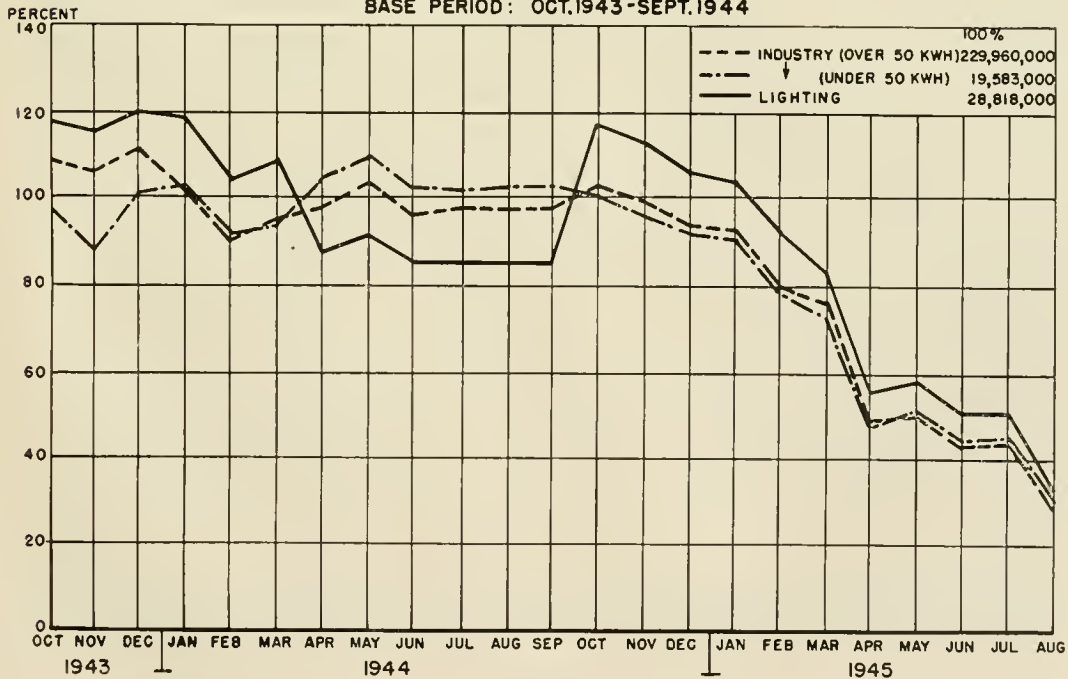


Graph 7.

ELECTRIC POWER CONSUMPTION

TOKYO - YOKOHAMA - KAWASAKI

BASE PERIOD: OCT. 1943 - SEPT. 1944

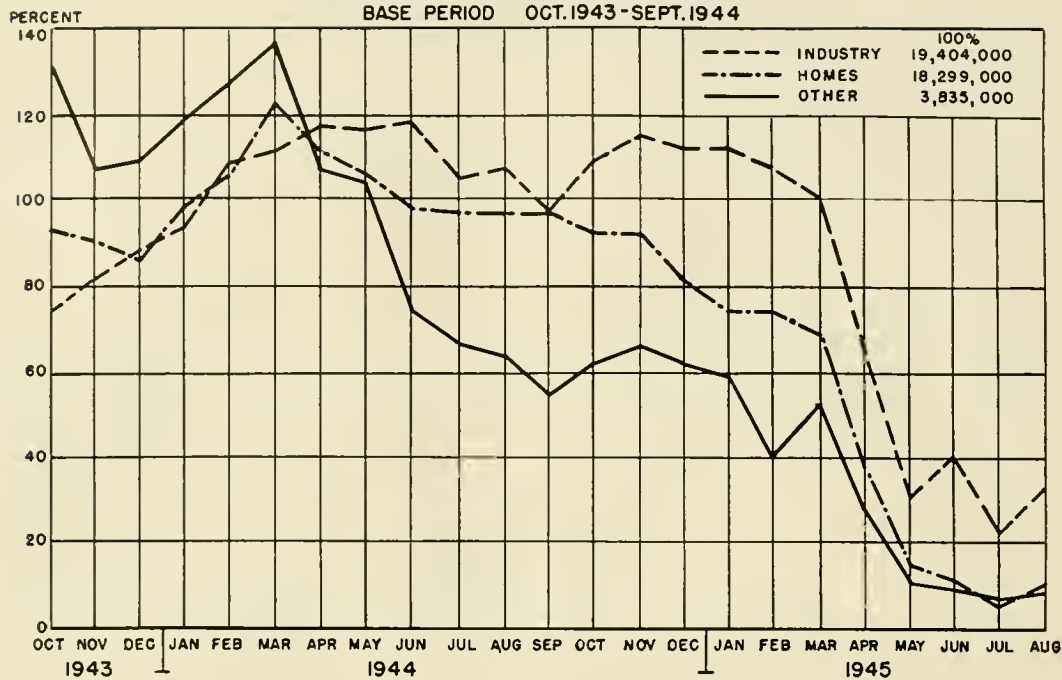


Graph 8.

GAS CONSUMPTION

TOKYO - YOKOHAMA - KAWASAKI

BASE PERIOD OCT.1943-SEPT.1944

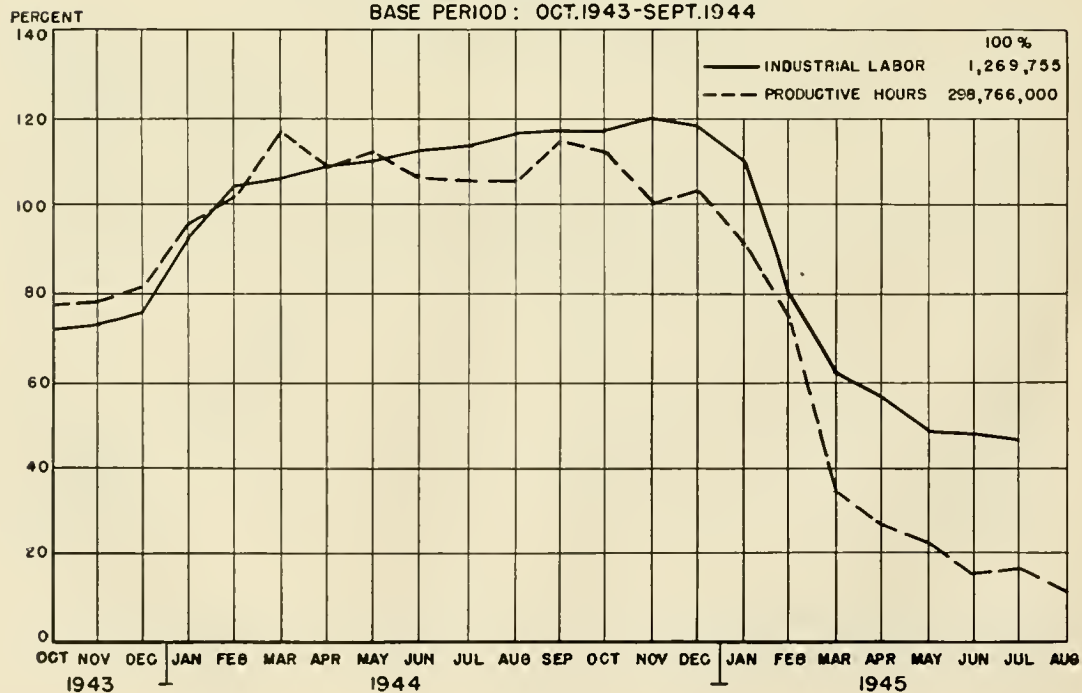


Graph 9.

INDUSTRIAL LABOR & PRODUCTIVE HOURS

TOKYO - YOKOHAMA - KAWASAKI

BASE PERIOD: OCT.1943-SEPT.1944

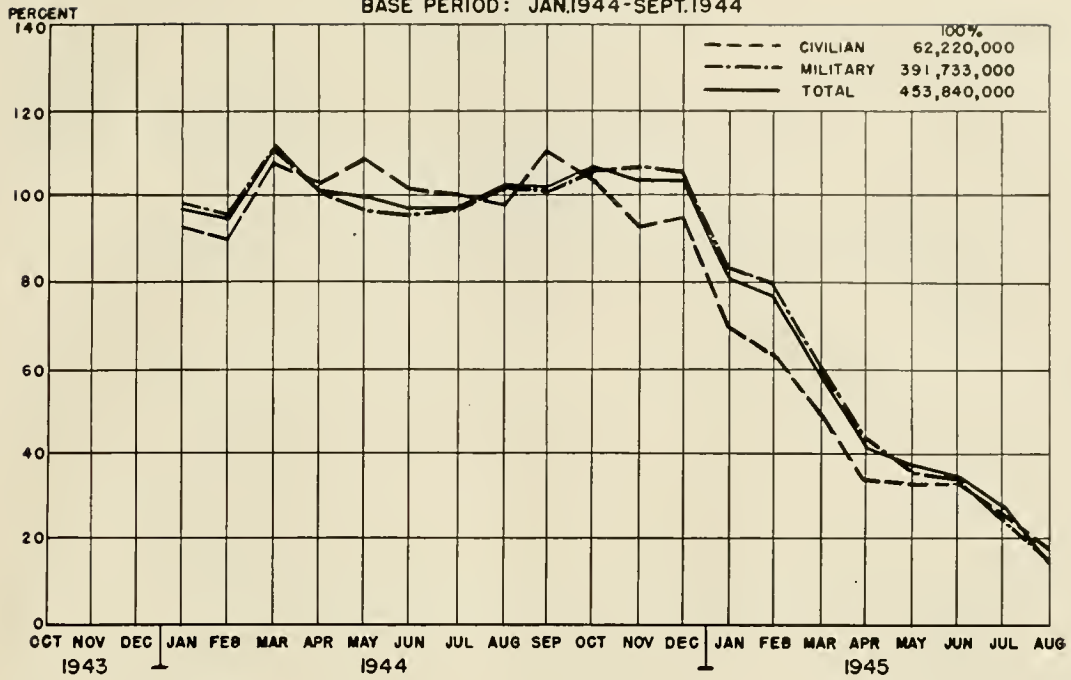


Graph 10.

PRODUCTION

TOKYO - YOKOHAMA - KAWASAKI

BASE PERIOD: JAN.1944-SEPT.1944

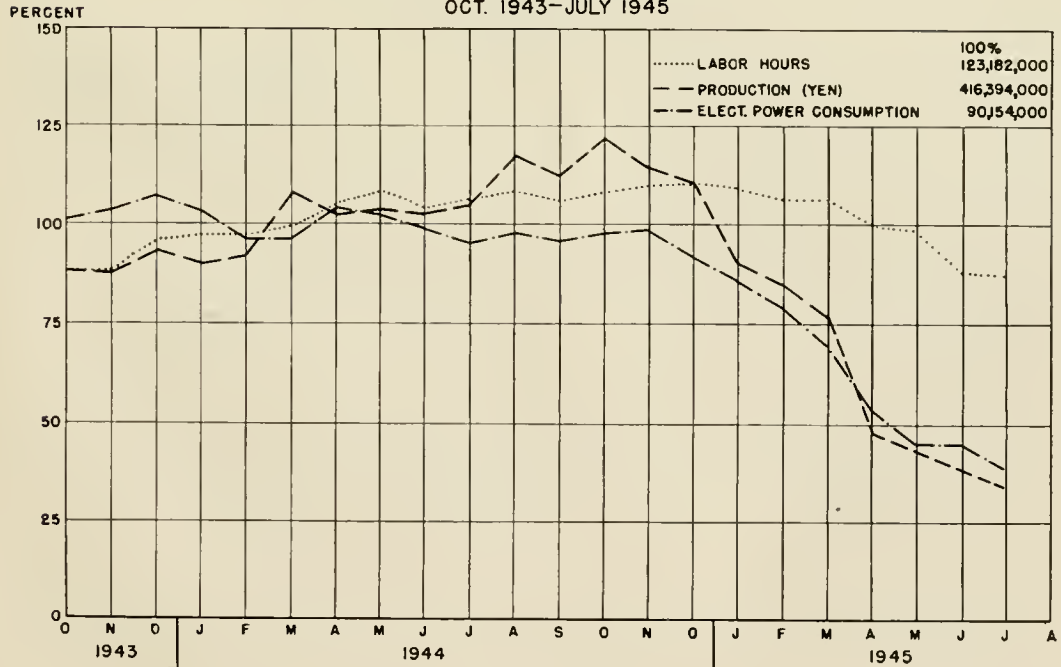


Graph 11.

TOTAL PLANT SAMPLE

TOKYO-YOKOHAMA-KAWASAKI

OCT. 1943-JULY 1945

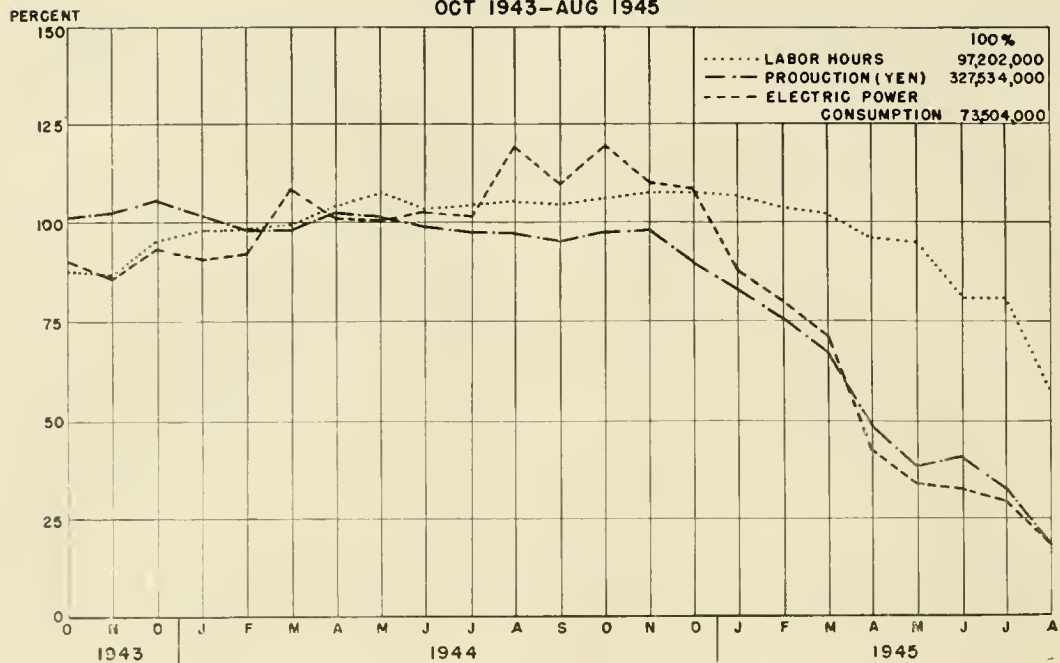


Graph 12.

TOTAL HIT PLANTS

TOKYO-YOKOHAMA-KAWASAKI

OCT 1943-AUG 1945

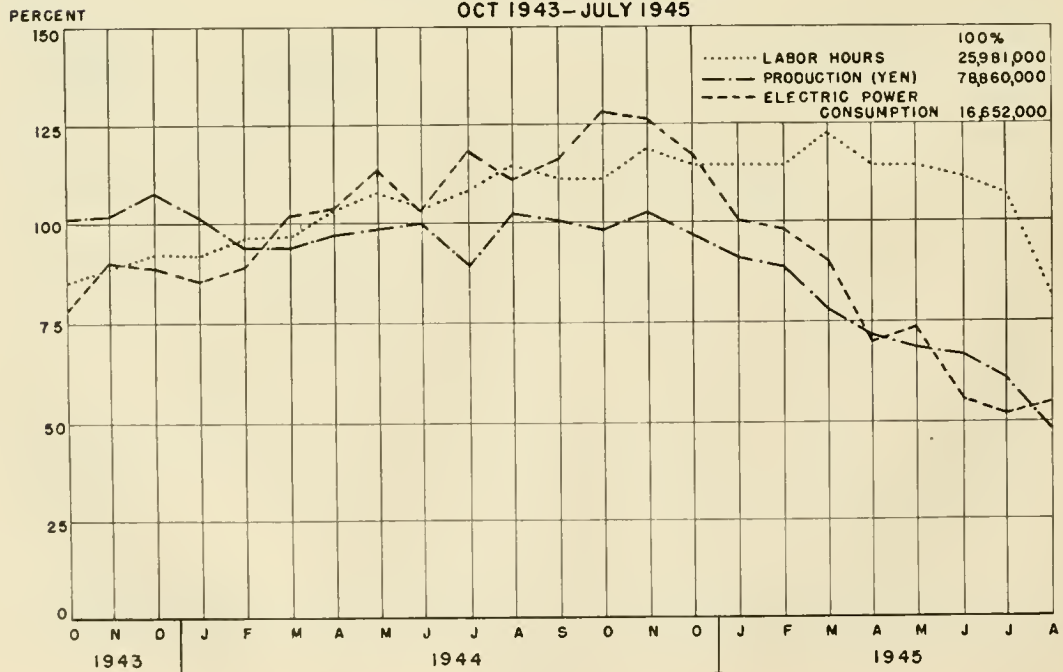


Graph 13.

TOTAL UNHIT PLANTS

TOKYO-YOKOHAMA-KAWASAKI

OCT 1943-JULY 1945

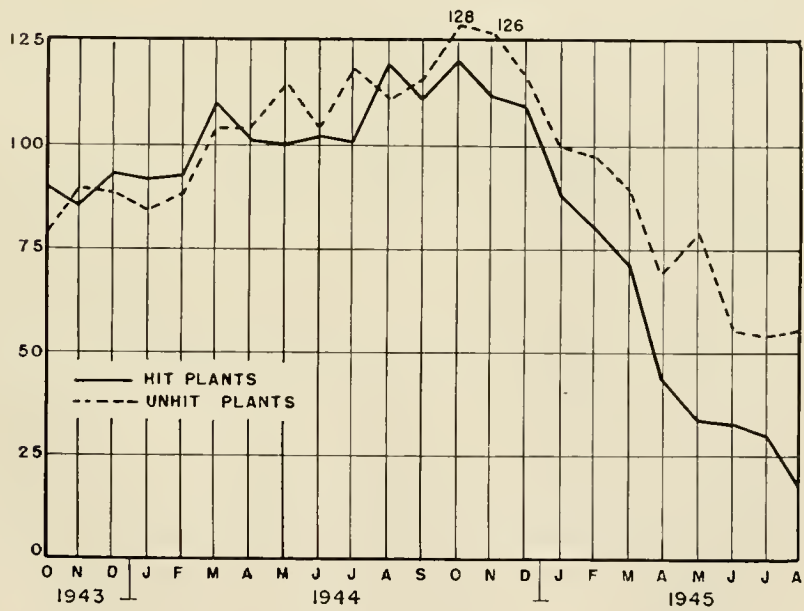
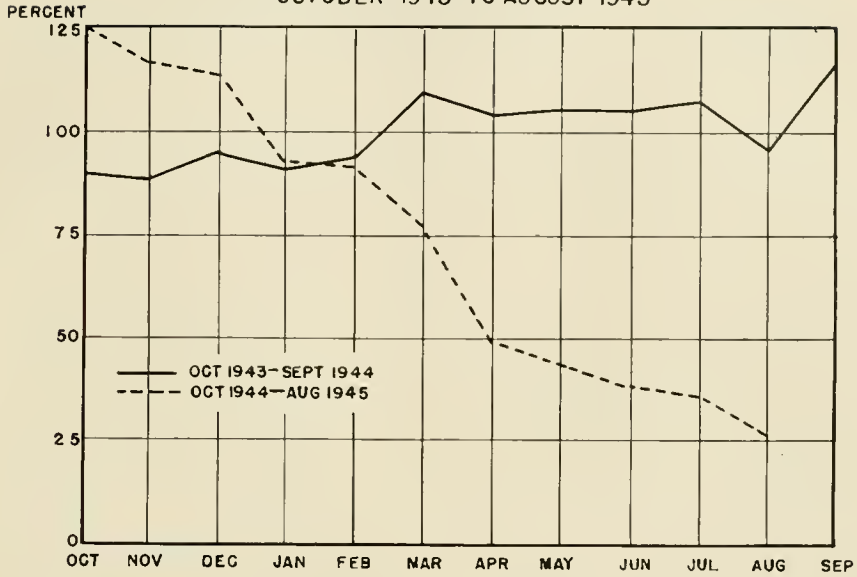


Graph 14.

PRODUCTION

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

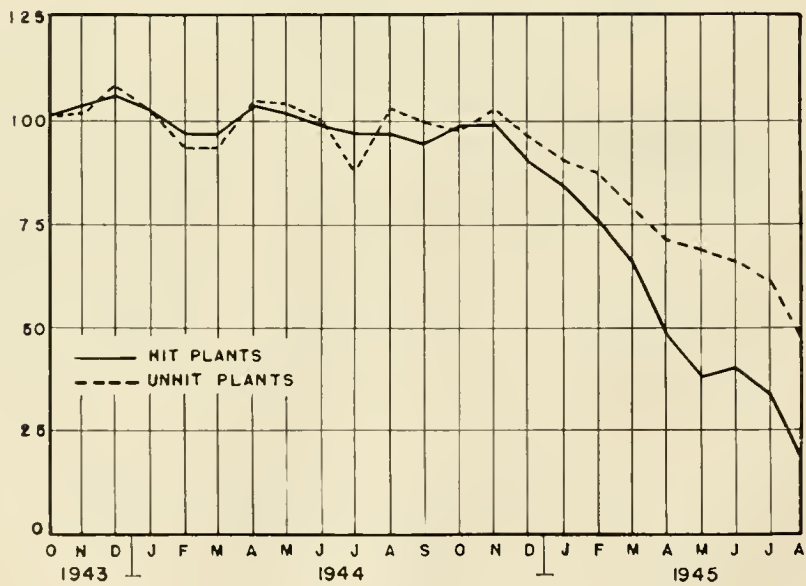
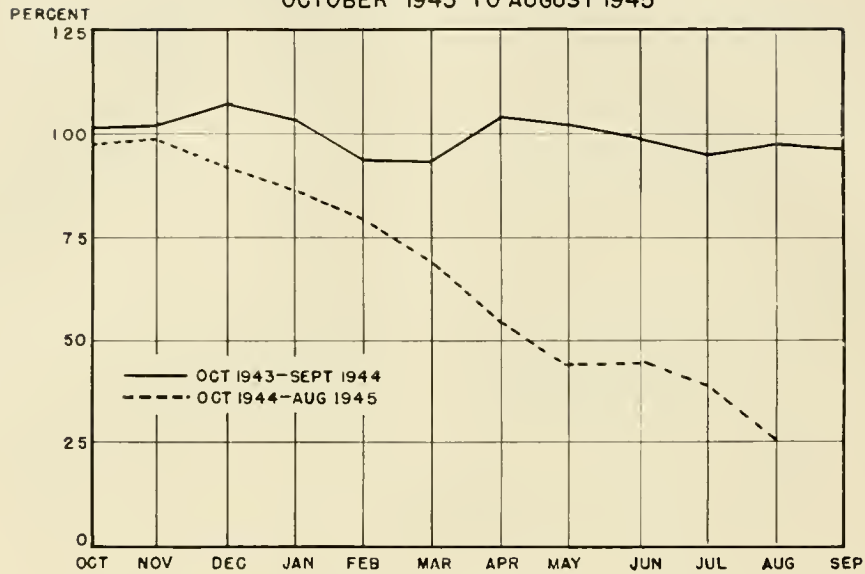


Graph 14-A.

ELECTRIC POWER CONSUMPTION

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

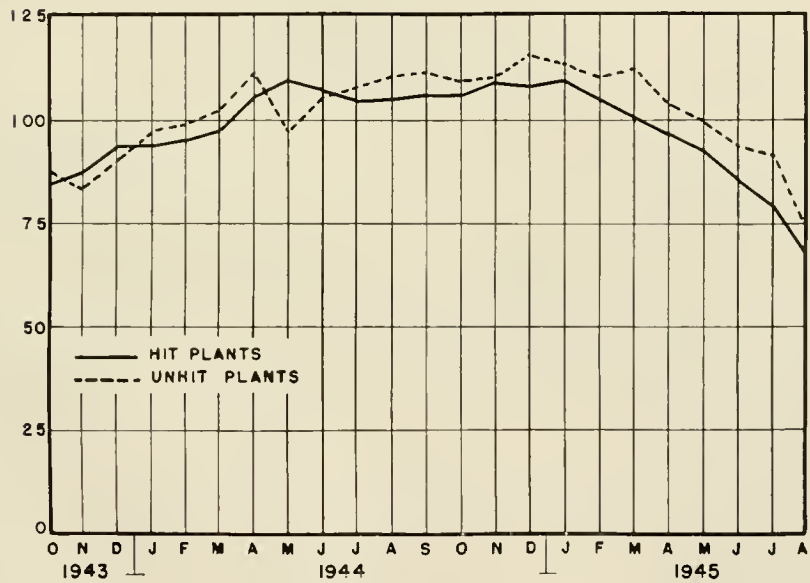
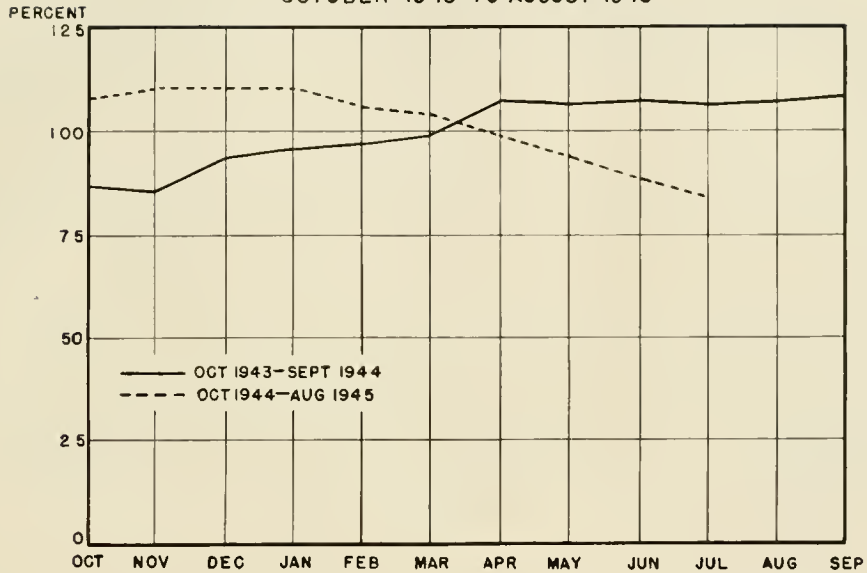


Graph 14-B.

LABOR FORCE

TOKYO-YOKOHAMA-KAWASAKI

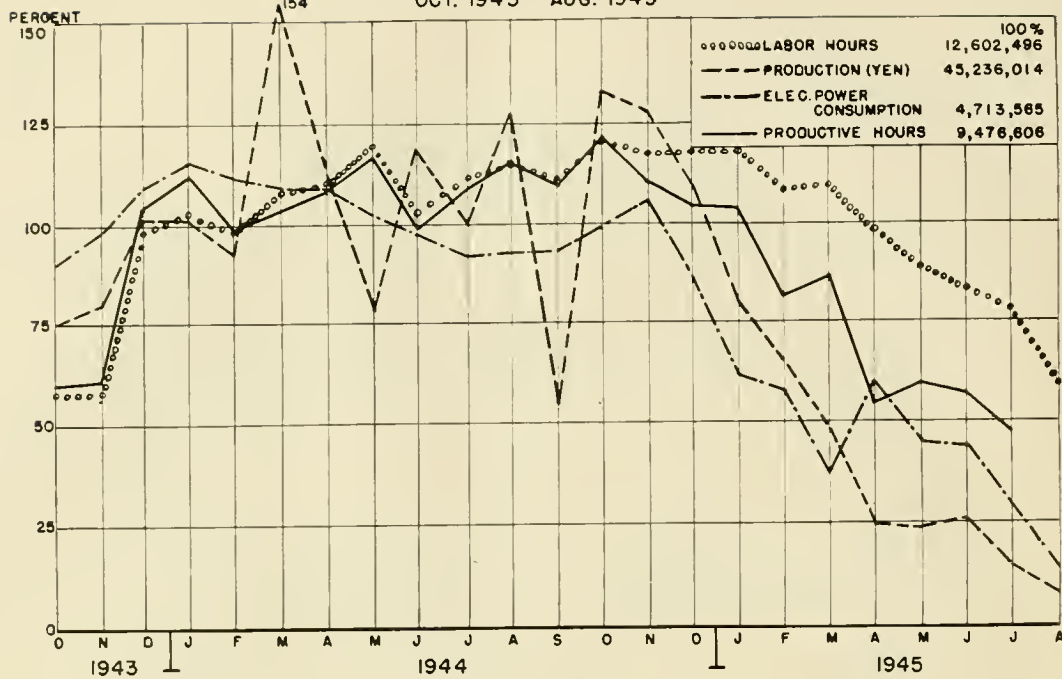
OCTOBER 1943 TO AUGUST 1945



Graph 14-C.

AIRCRAFT TOKYO - YOKOHAMA-KAWASAKI

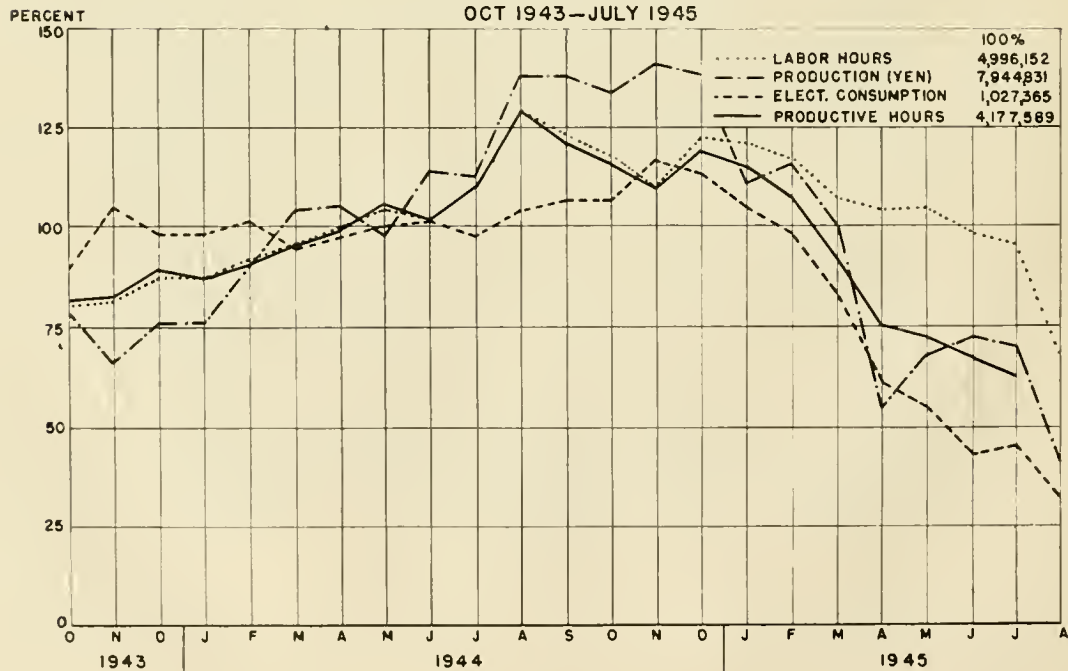
OCT. 1943 - AUG. 1945



Graph 15.

ORDNANCE TOKYO-YOKOHAMA-KAWASAKI

OCT 1943-JULY 1945

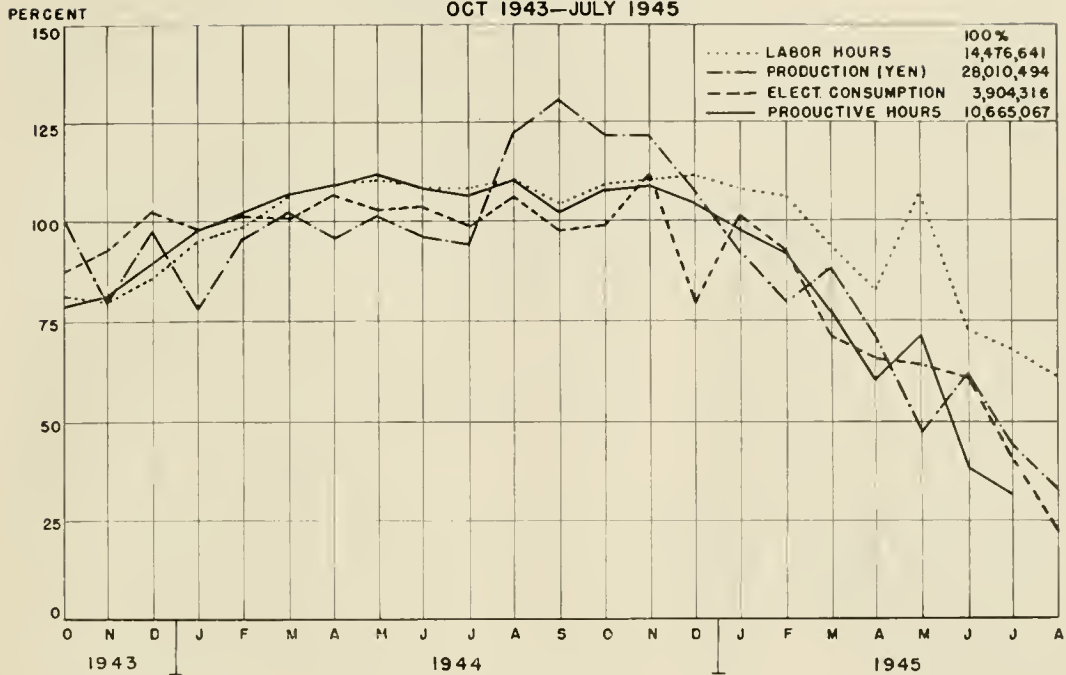


Graph 16.

SHIPBUILDING & REPAIR

TOKYO-YOKOHAMA-KAWASAKI

OCT 1943-JULY 1945

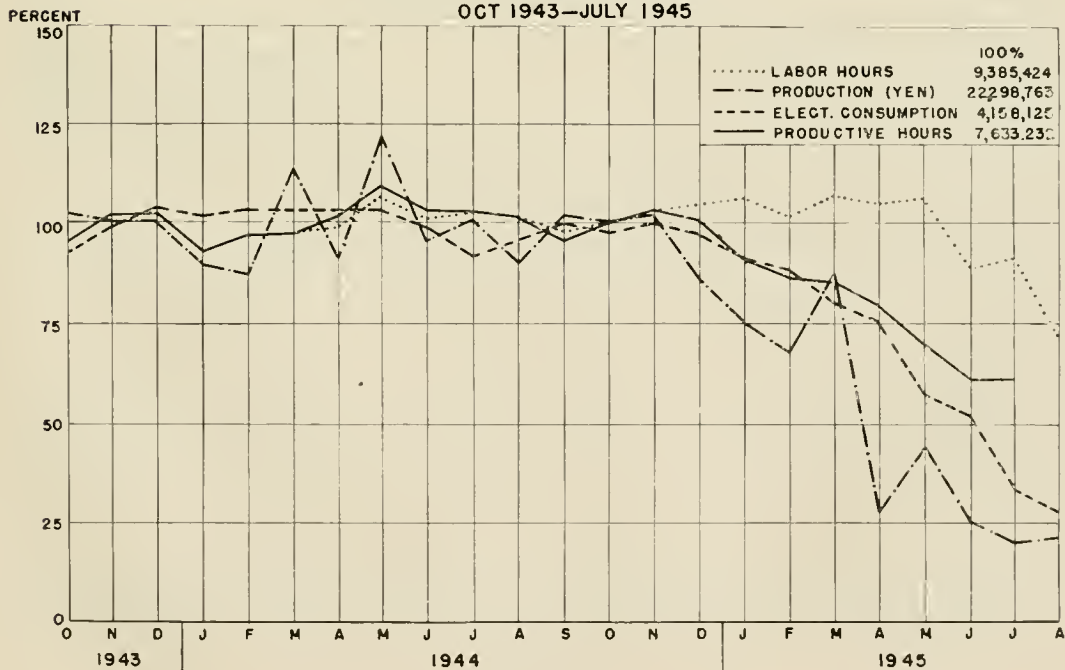


Graph 17.

MOTOR VEHICLES

TOKYO-YOKOHAMA-KAWASAKI

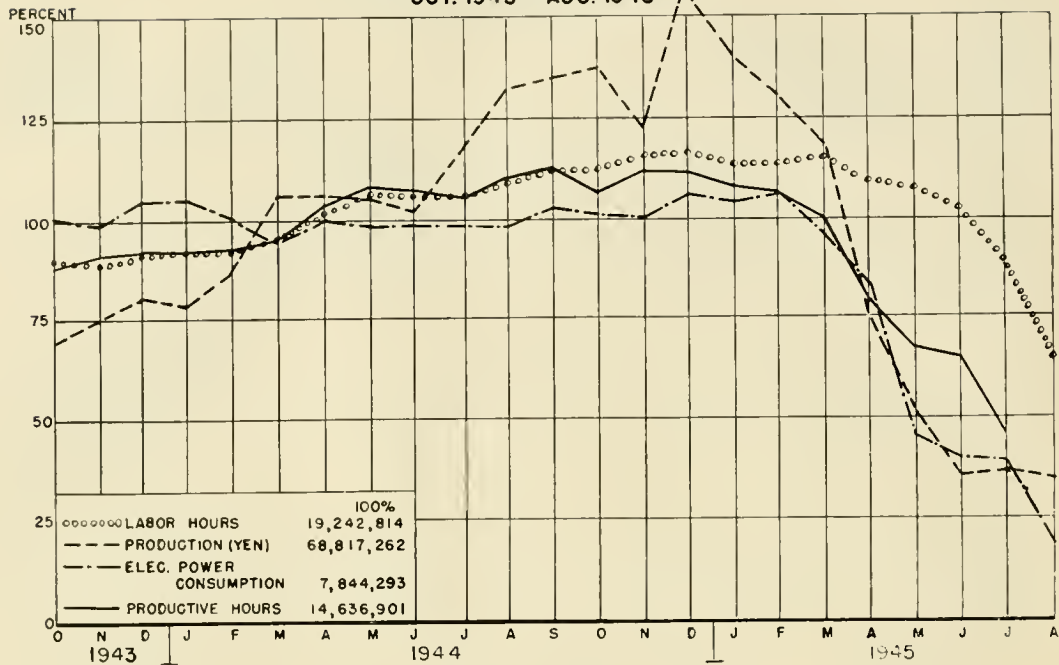
OCT 1943-JULY 1945



Graph 18.

ELECTRICAL PRODUCTS- TOKYO - YOKOHAMA - KAWASAKI

OCT. 1943 - AUG. 1945

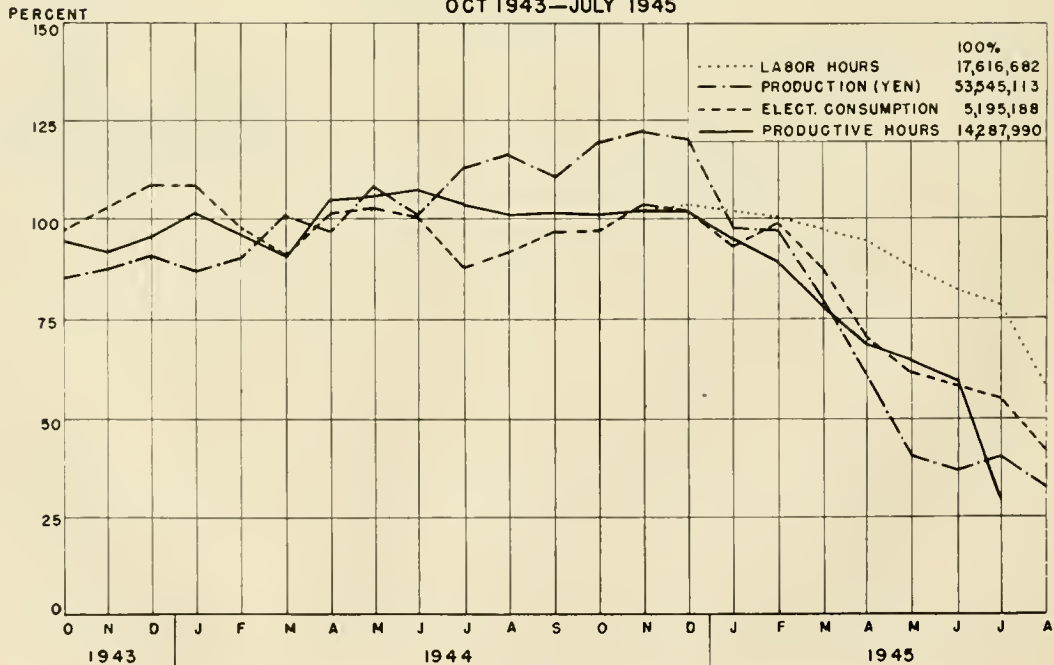


Graph 19.

MACHINERY & TOOLS

TOKYO-YOKOHAMA-KAWASAKI

OCT 1943-JULY 1945

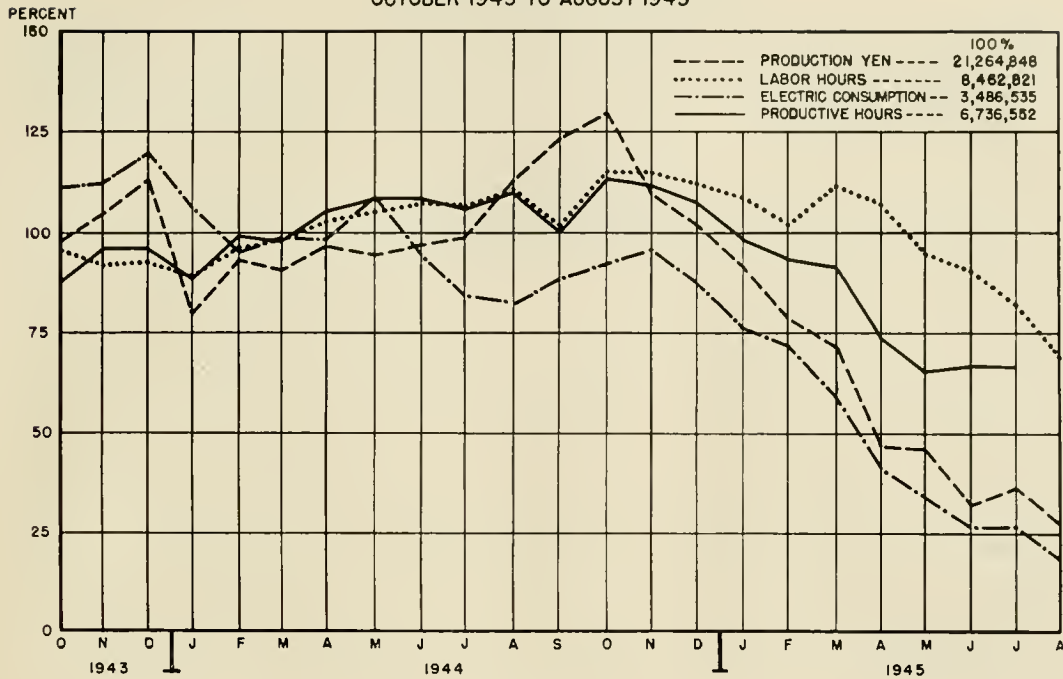


Graph 20.

METAL PRODUCTS

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

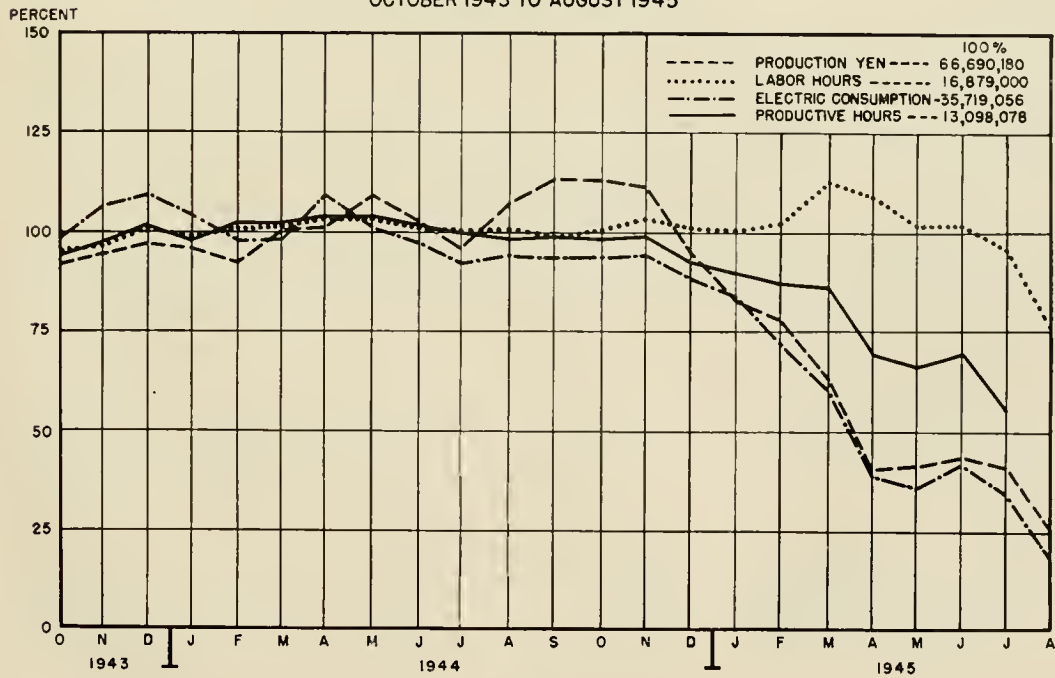


Graph 21.

BASIC METALS

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

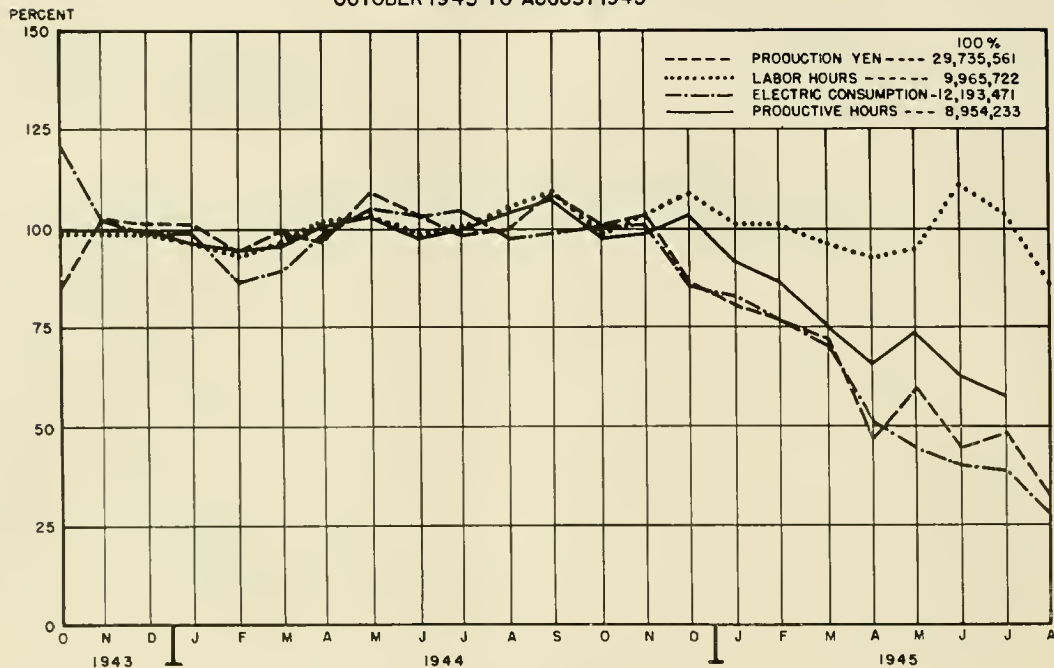


Graph 22.

CHEMICALS

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

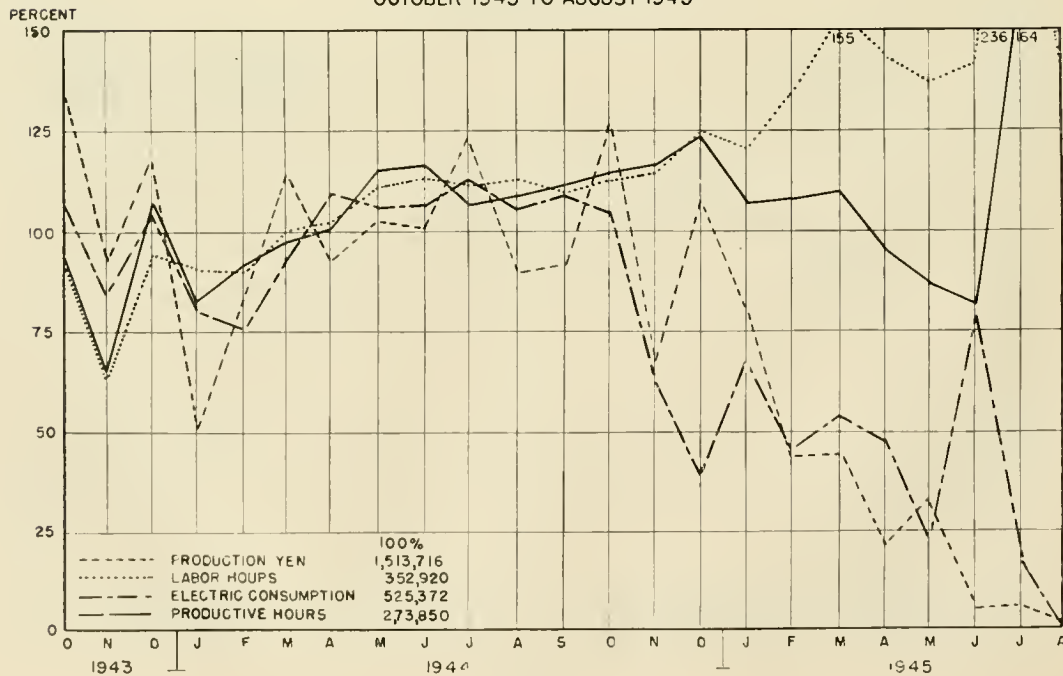


Graph 23.

PETROLEUM

TOKYO-YOKOHAMA-KAWASAKI

OCTOBER 1943 TO AUGUST 1945

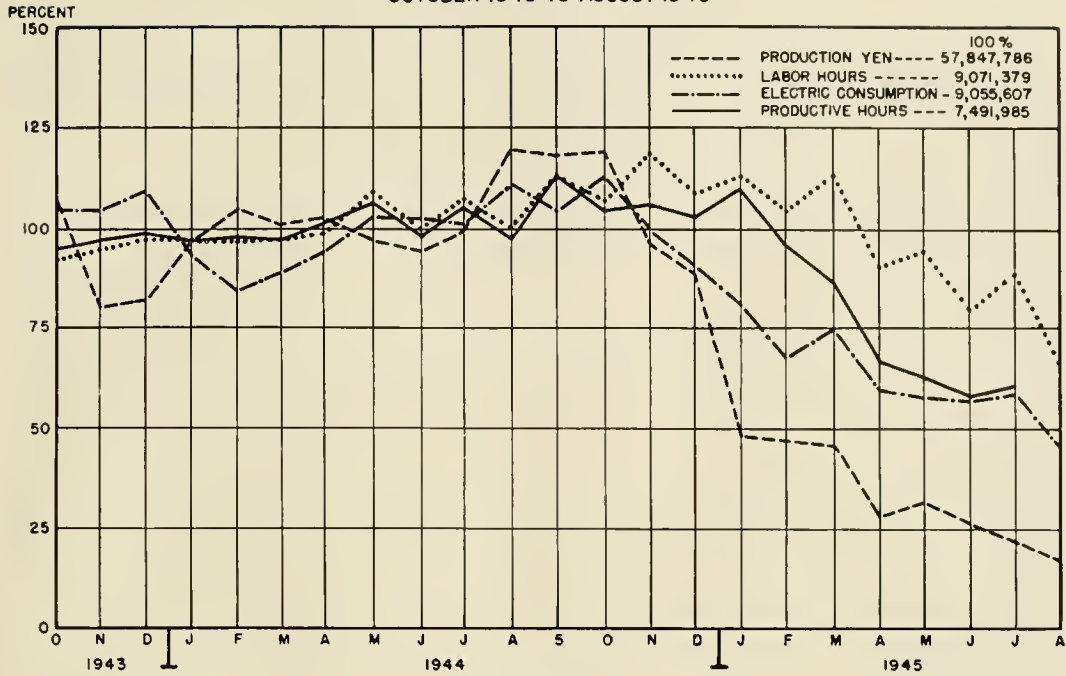


Graph 24.

MISCELLANEOUS INDUSTRIES

TOKYO - YOKOHAMA - KAWASAKI

OCTOBER 1943 TO AUGUST 1945

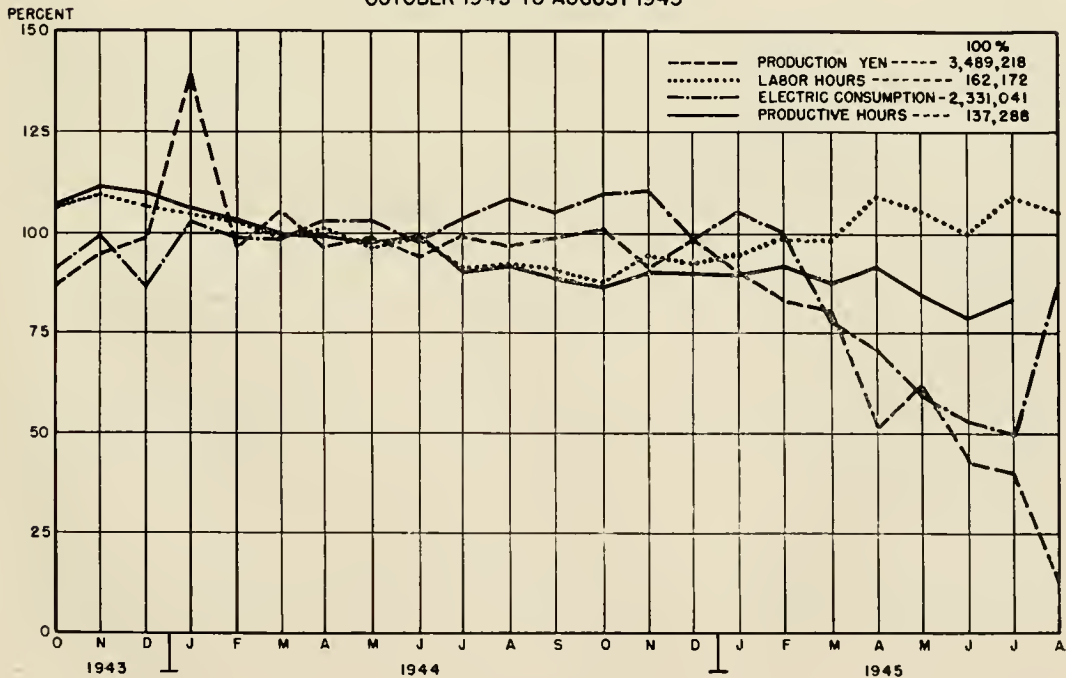


Graph 25.

PUBLIC UTILITIES

TOKYO - YOKOHAMA - KAWASAKI

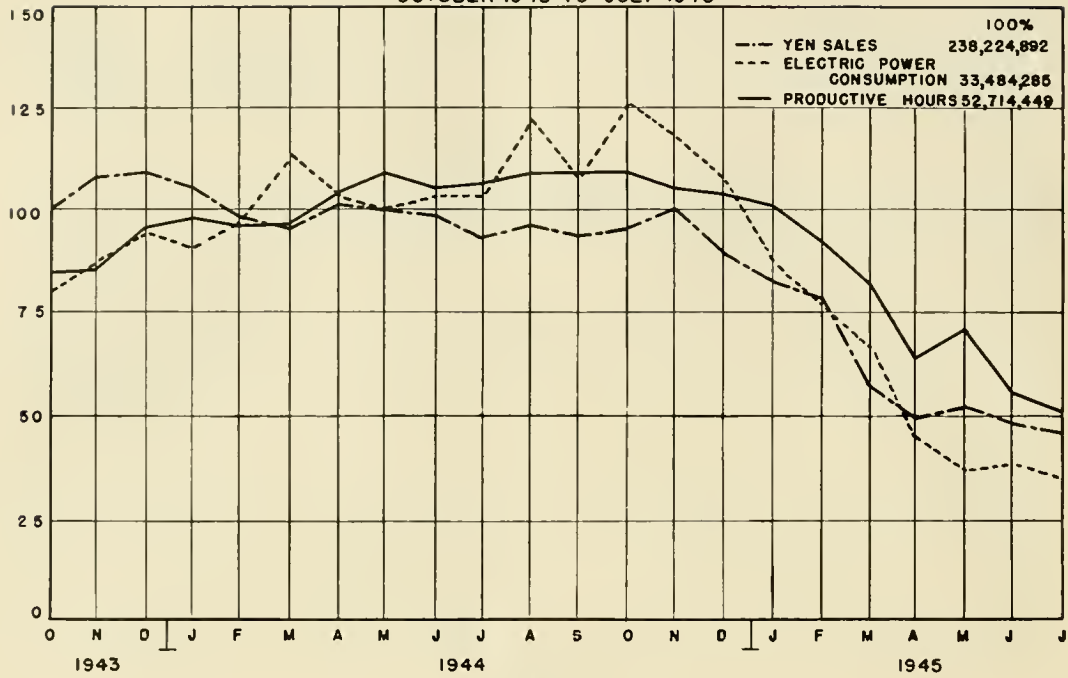
OCTOBER 1943 TO AUGUST 1945



Graph 26.

TOTAL PLANT SAMPLE TOKYO

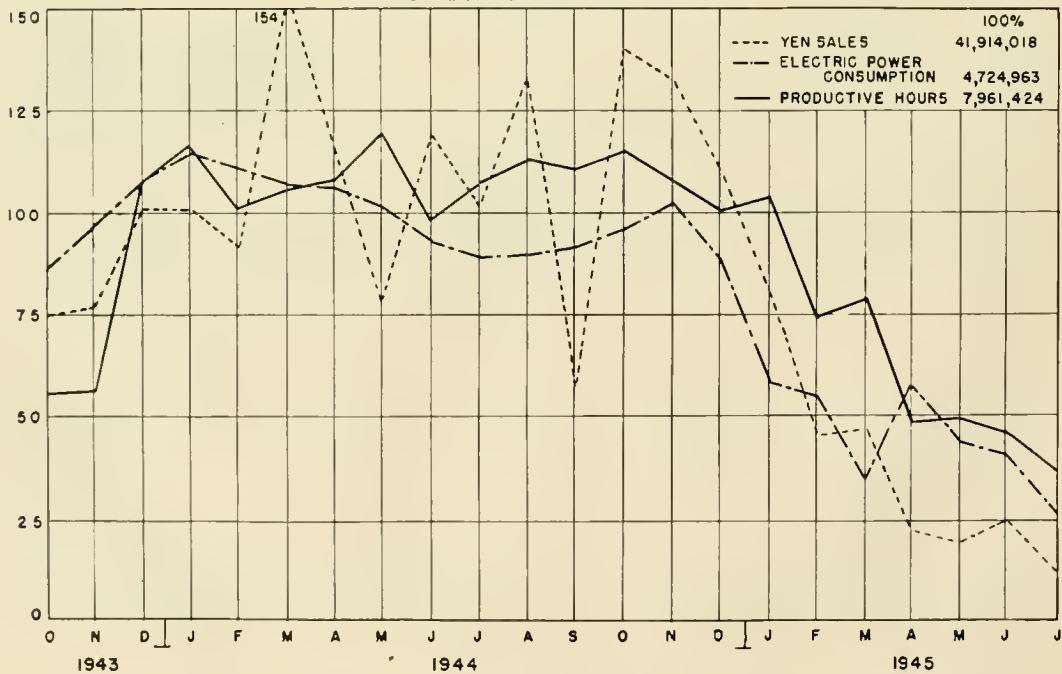
OCTOBER 1943 TO JULY 1945



Graph 27.

AIRCRAFT TOKYO

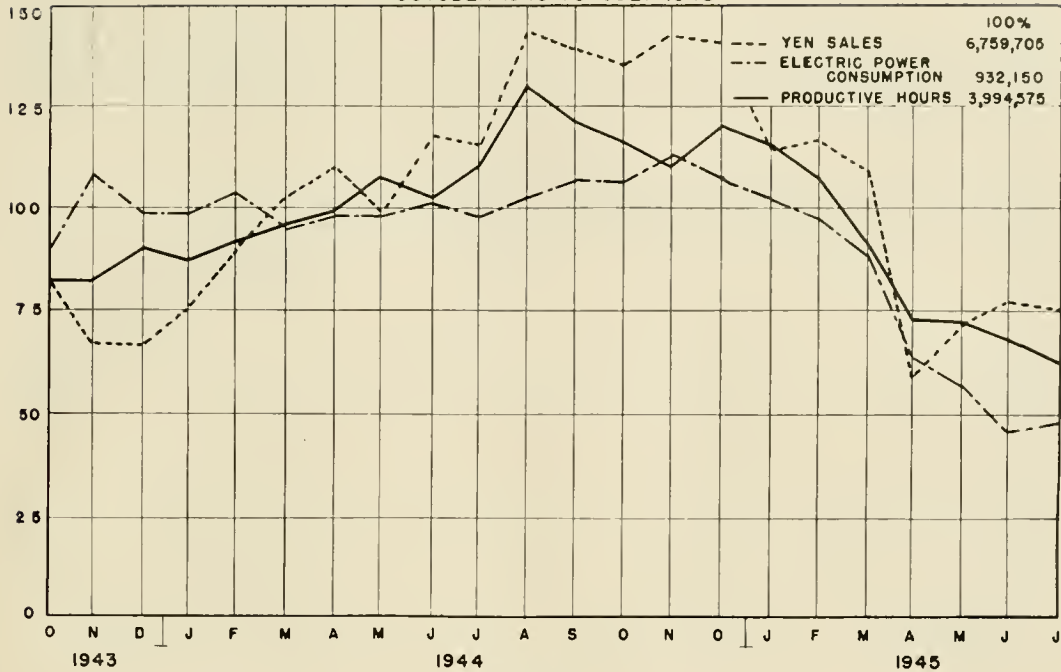
OCTOBER 1943 TO JULY 1945



Graph 28.

ORDNANCE TOKYO

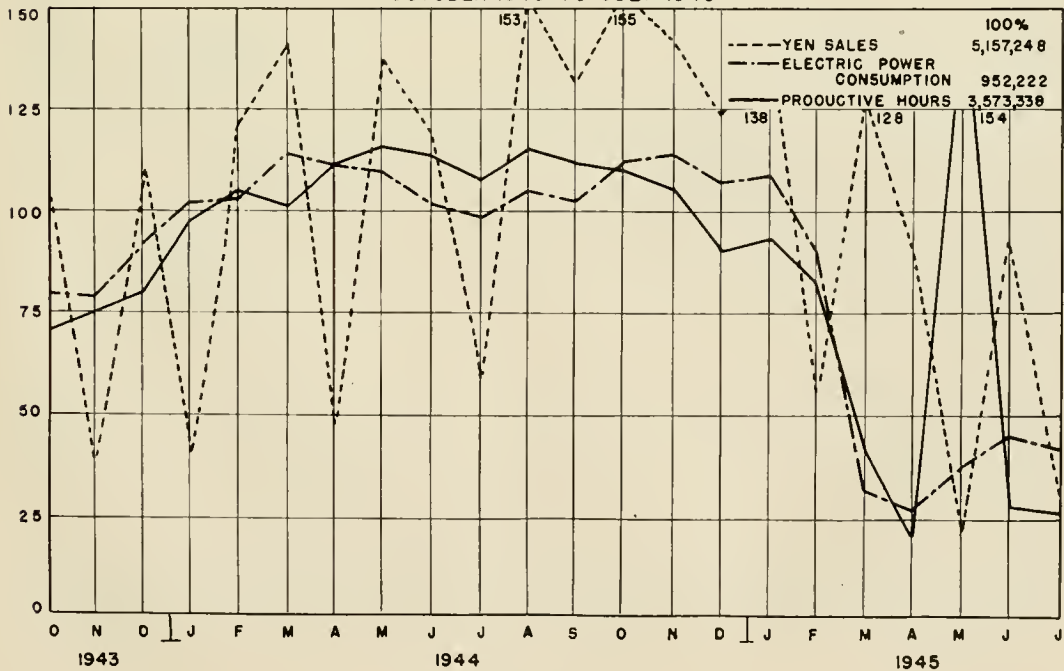
OCTOBER 1943 TO JULY 1945



Graph 29.

SHIPBUILDING TOKYO

OCTOBER 1943 TO JULY 1945

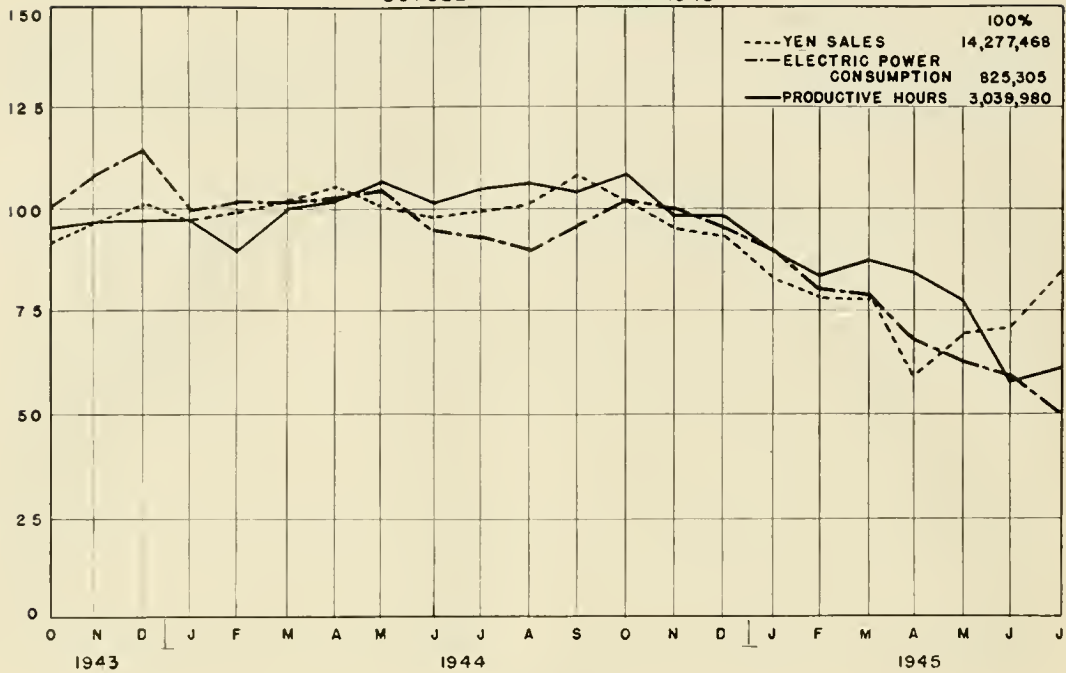


Graph 30.

MOTOR VEHICLES

TOKYO

OCTOBER 1943 TO JULY 1945

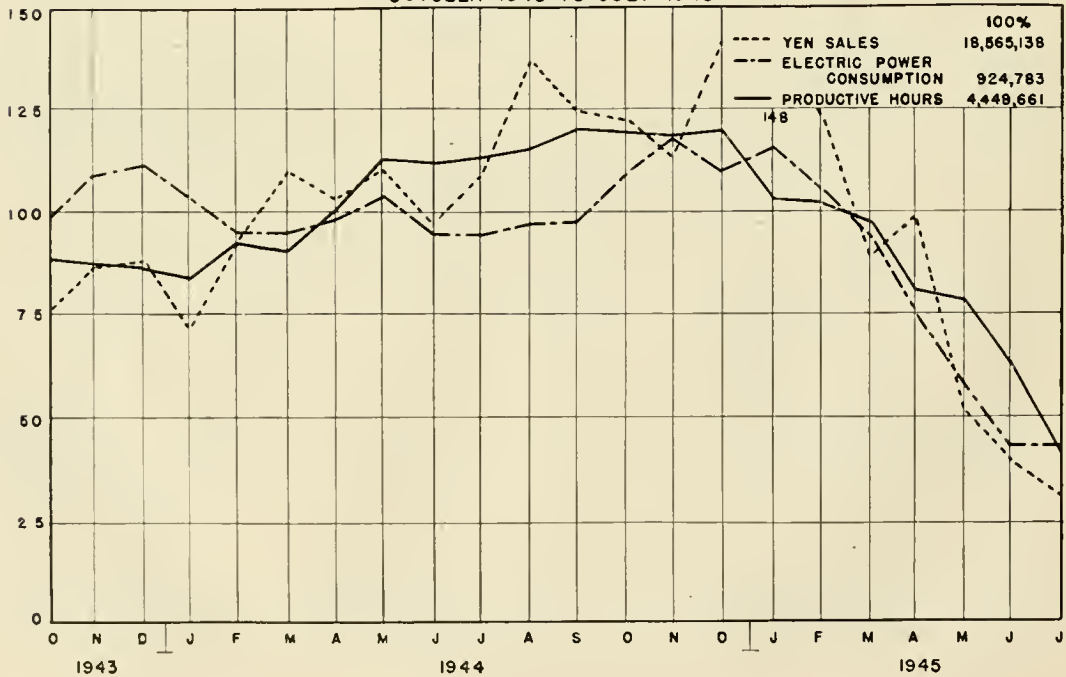


Graph 31.

ELECTRIC EQUIPMENT

TOKYO

OCTOBER 1943 TO JULY 1945

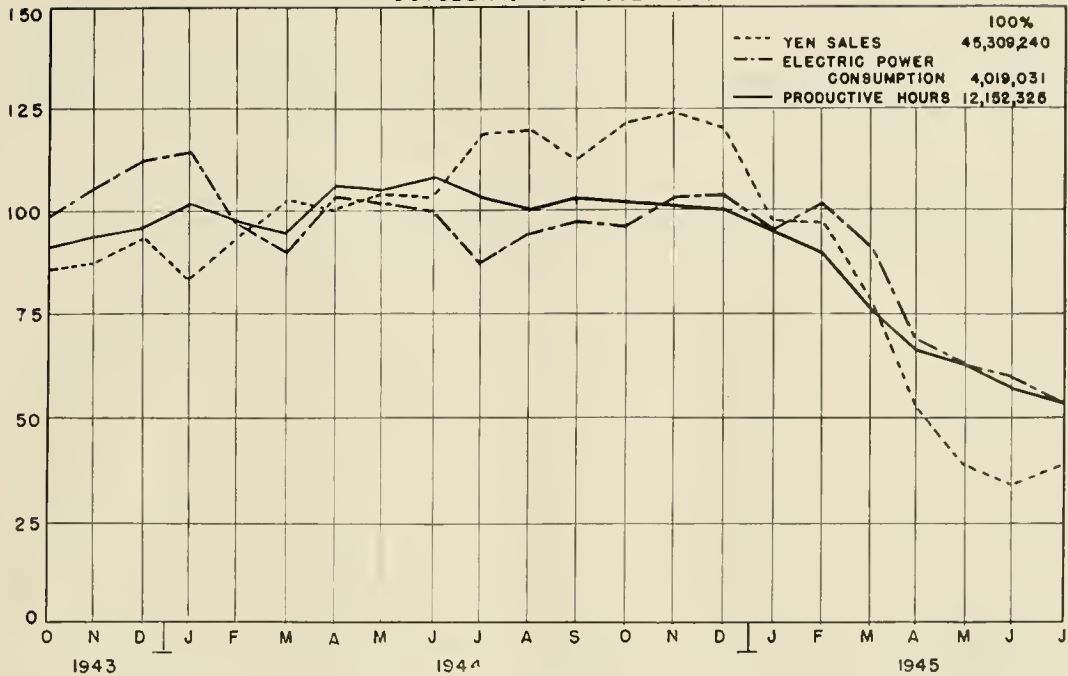


Graph 32.

MACHINE & TOOLS

TOKYO

OCTOBER 1943 TO JULY 1945

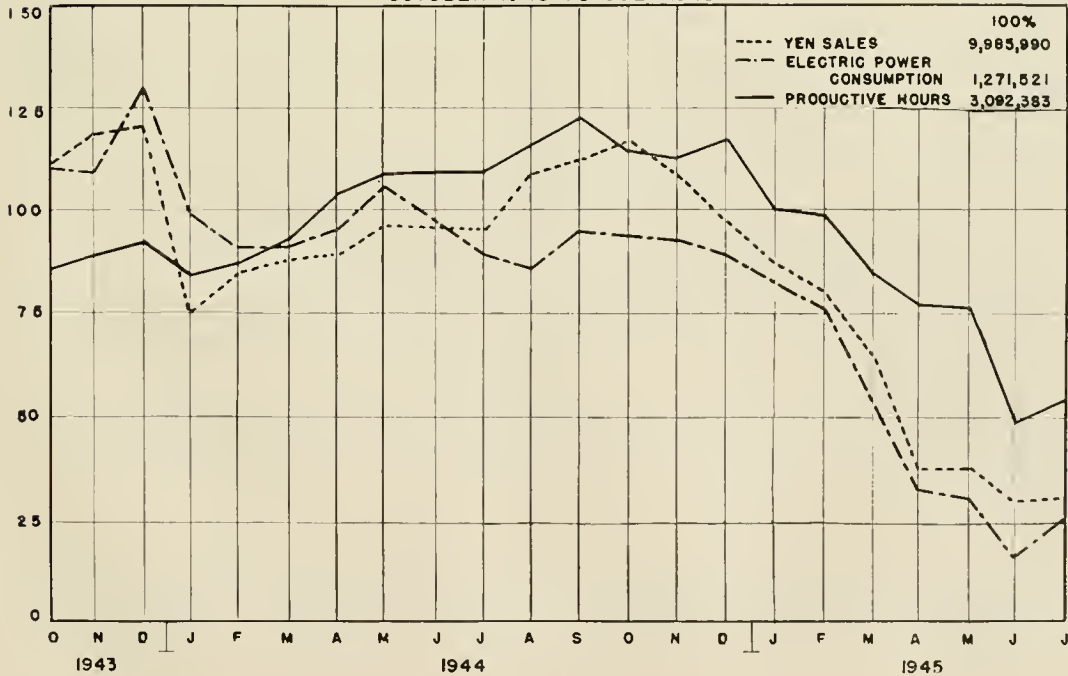


Graph 33.

METAL PRODUCTS

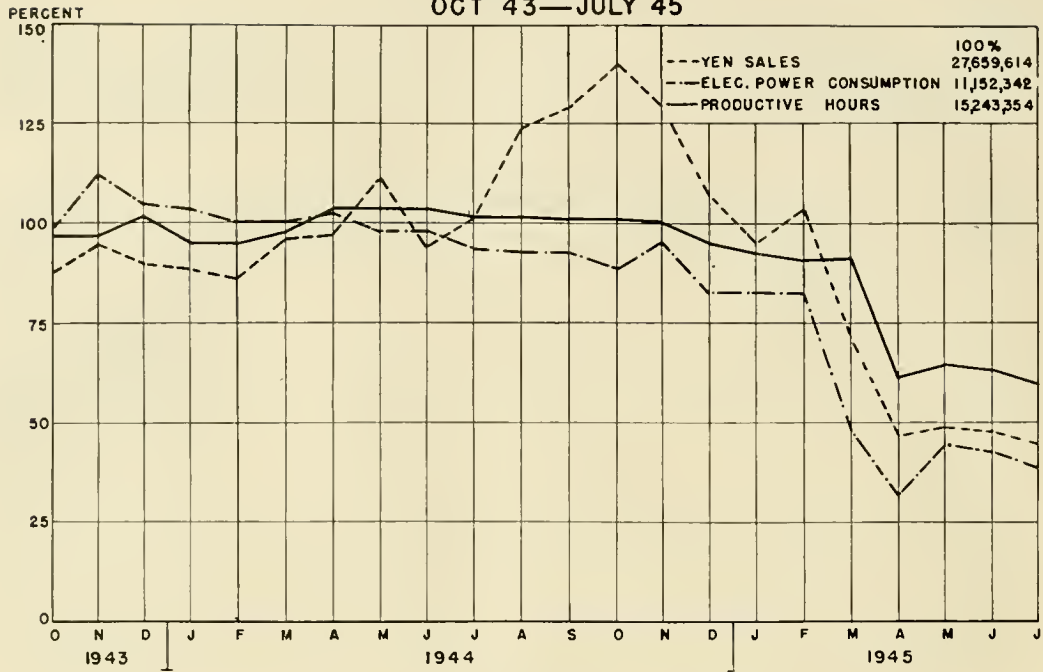
TOKYO

OCTOBER 1943 TO JULY 1945



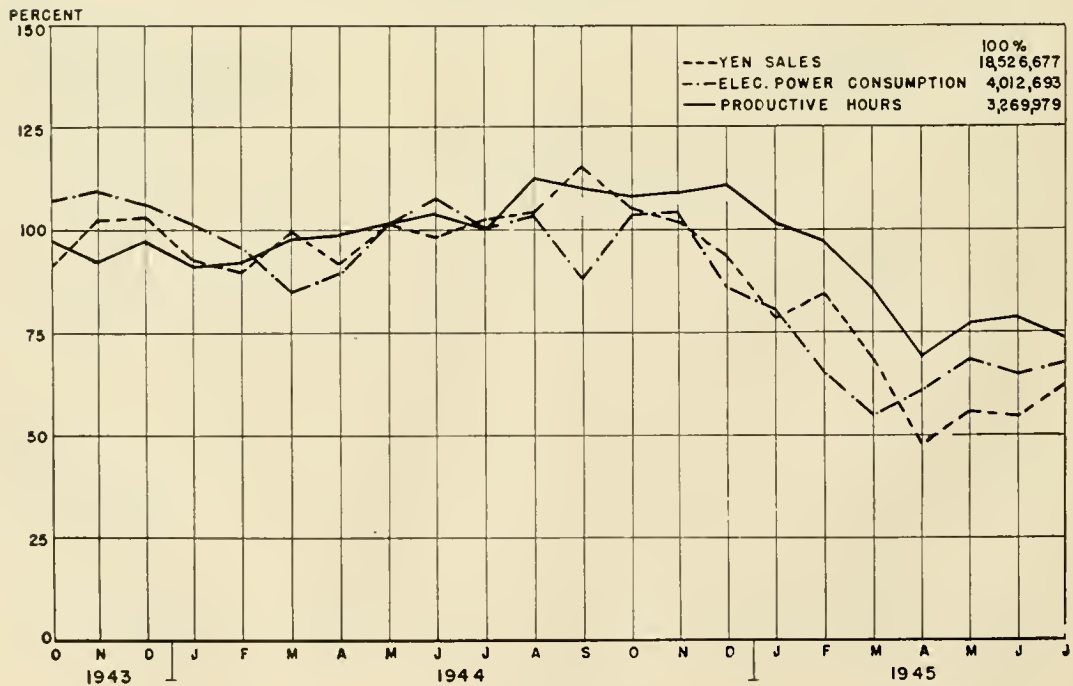
Graph 34.

TOKYO BASIC METALS PRODUCTION OCT 43—JULY 45



Graph 35.

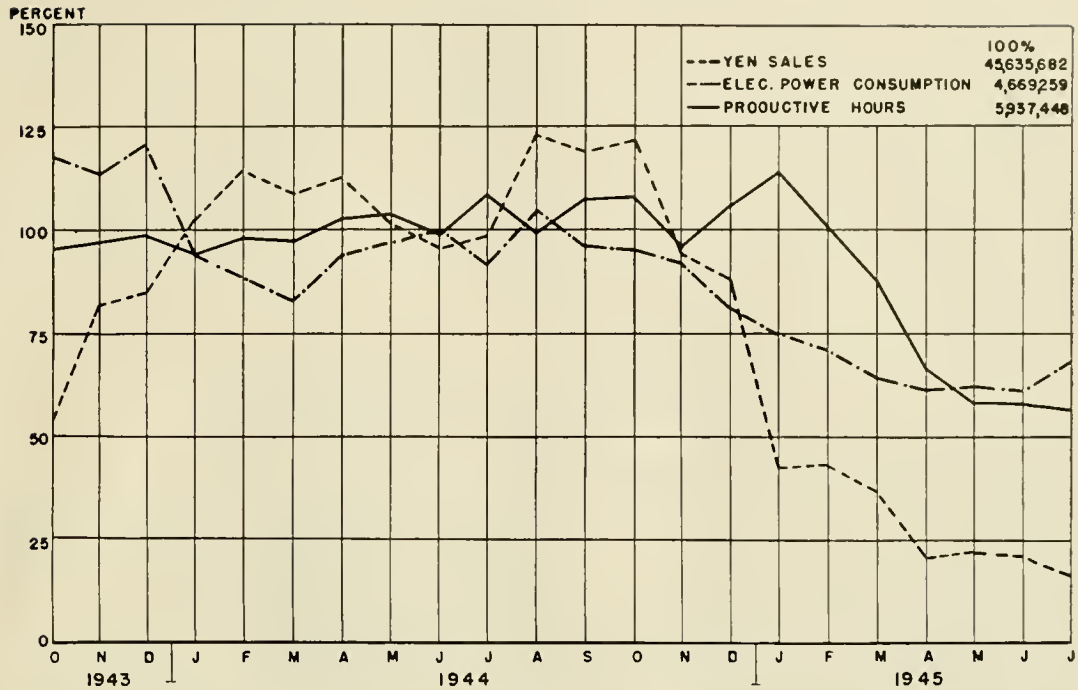
TOKYO CHEMICALS OCT 43—JULY 45



Graph 36.

TOKYO MISCELLANEOUS

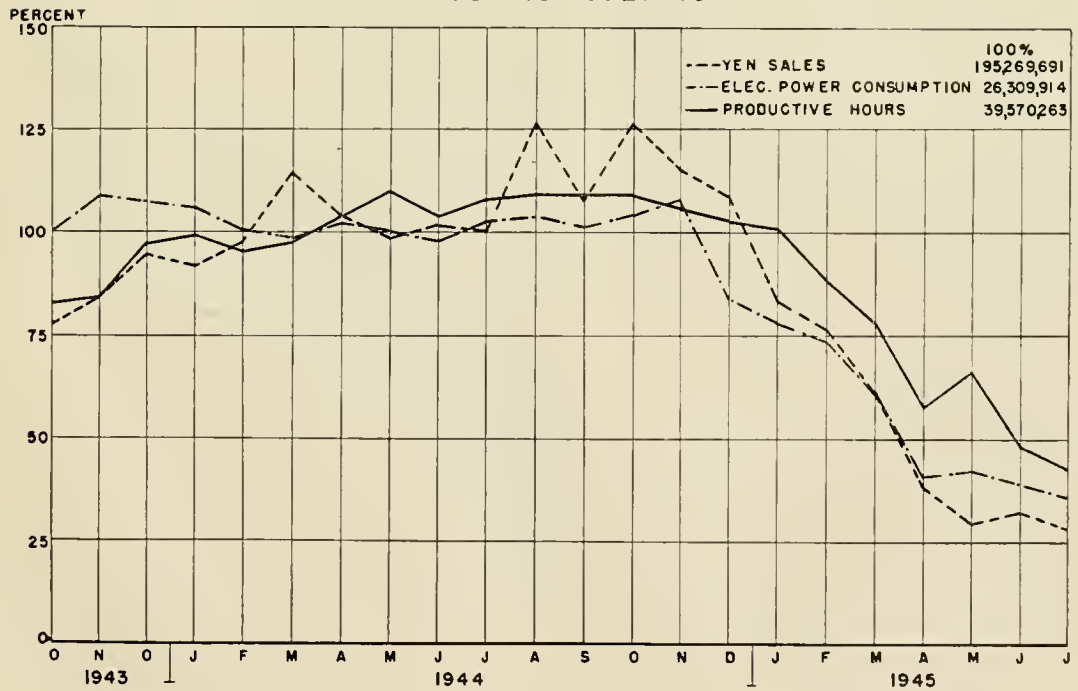
OCT 43—JULY 45



Graph 37.

TOKYO HIT PLANTS

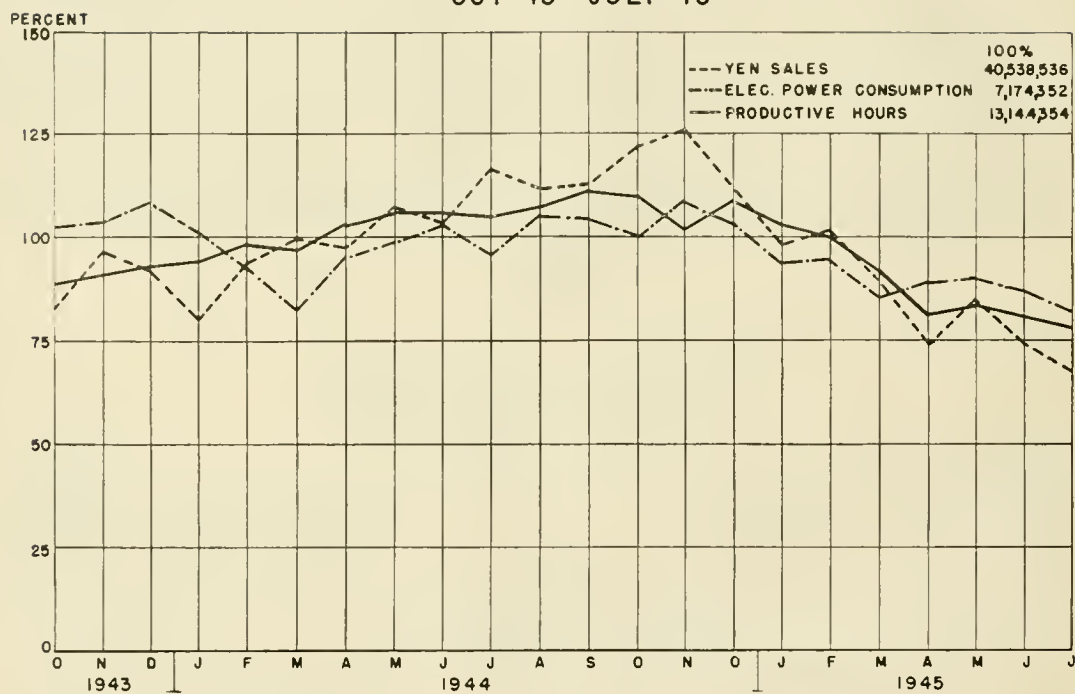
OCT 43—JULY 45



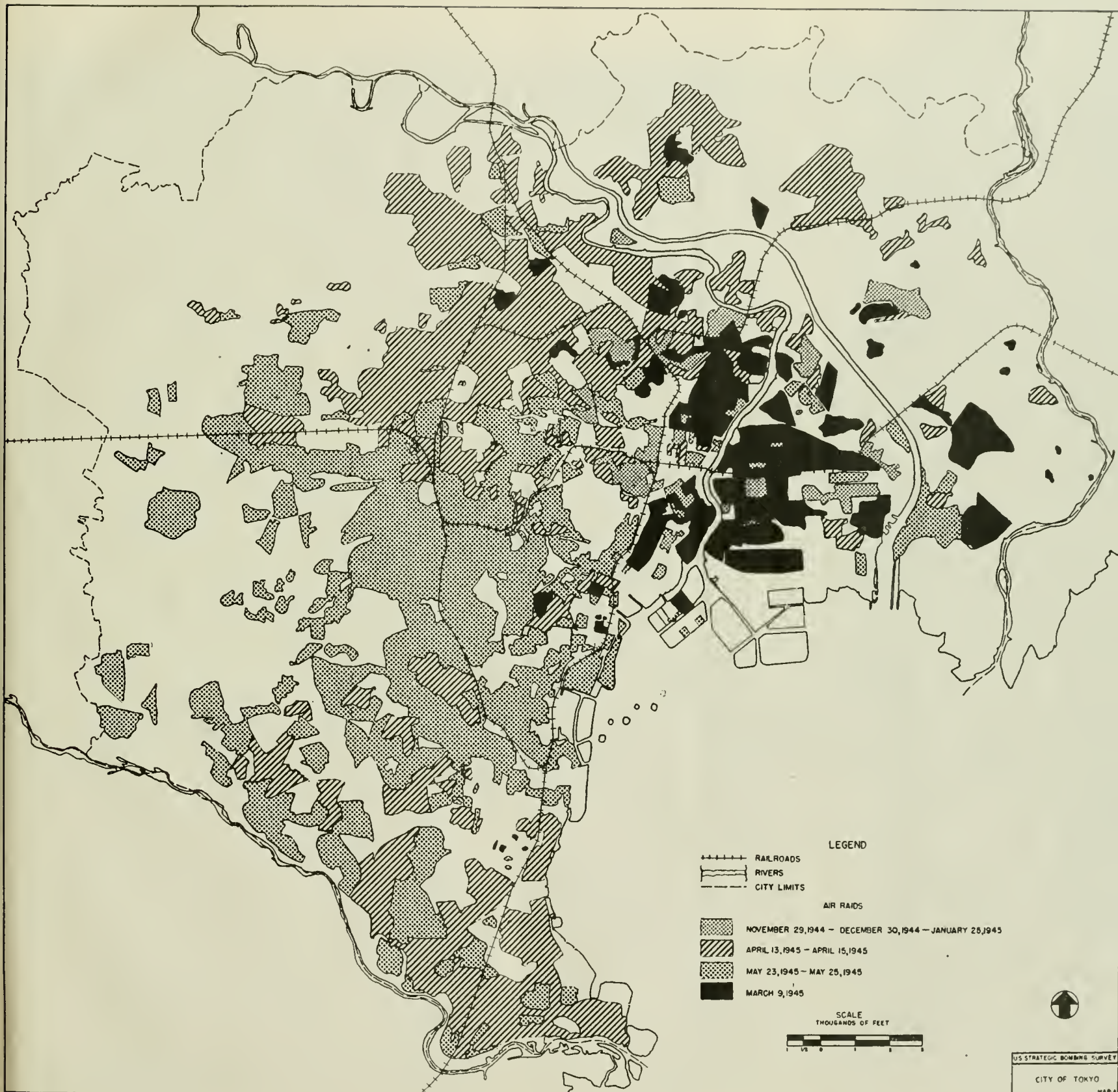
Graph 38.

TOKYO UNHIT PLANTS

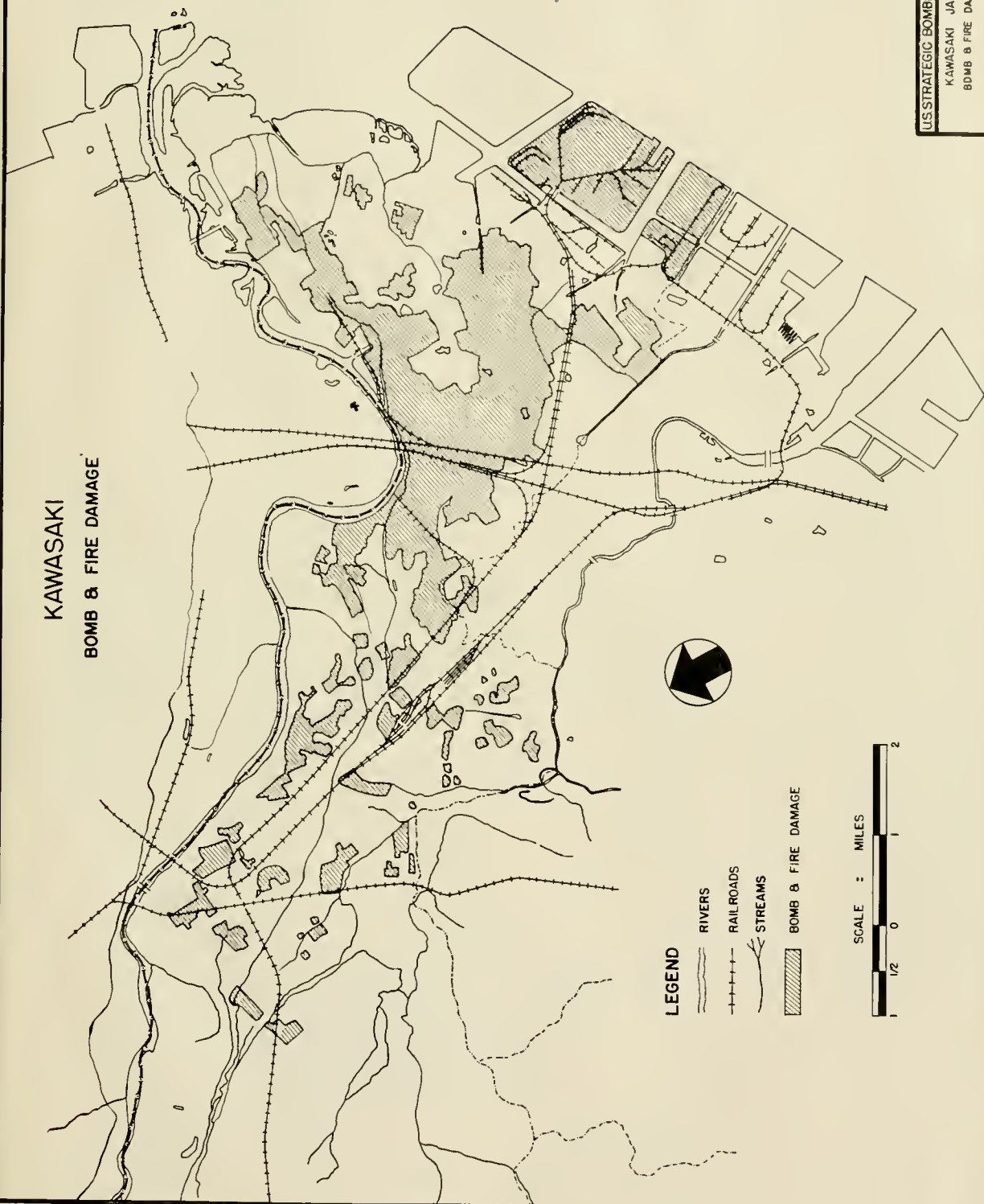
OCT 43—JULY 45



Graph 39.



KAWASAKI BOMB & FIRE DAMAGE



LEGEND

- RIVERS
- RAILROADS
- STREAMS
- BOMB & FIRE DAMAGE



US STRATEGIC BOMBING SURVEY
KAWASAKI JAPAN
BOMB & FIRE DAMAGE
MAP B

LEGEND

- UNDAMAGED BUILT-UP AREAS
- 4 APRIL FIRE DAMAGE
- 25 APRIL FIRE DAMAGE
- 24 MAY FIRE DAMAGE
- 29 MAY FIRE DAMAGE
- 10 JUNE FIRE DAMAGE
- COAST LINE
- RAILROADS
- RIVERS
- CANALS



SCALE - FEET



UNITED STATES STRATEGIC BOMBING SURVEY

LIST OF REPORTS

The following is a bibliography of reports resulting from the Survey's studies of the European and Pacific wars. Those reports marked with an asterisk (*) may be purchased from the Superintendent of Documents at the Government Printing Office, Washington, D. C.

European War

OFFICE OF THE CHAIRMAN

- *1 The United States Strategic Bombing Survey: Summary Report (European War)
- *2 The United States Strategic Bombing Survey: Overall Report (European War)
- *3 The Effects of Strategic Bombing on the German War Economy

AIRCRAFT DIVISION

(By Division and Branch)

- *4 Aircraft Division Industry Report
- 5 Inspection Visits to Various Targets (Special Report)

Airframes Branch

- 6 Junkers Aircraft and Aero Engine Works, Dessau, Germany
- 7 Erla Maschinenwerke G m b H, Heiterblick, German
- 8 A T G Maschinenbau, G m b H, Leipzig (Mockau), Germany
- 9 Gothaer Waggonfabrik, A G, Gotha, Germany
- 10 Focke Wulf Aircraft Plant, Bremen, Germany
- 11 Messerschmitt A G, Augsburg, Germany
 - { Over-all Report
 - { Part A
 - { Part B
 - { Appendices I, II, III
- 12 Dornier Works, Friedrichshafen & Munich, Germany
- 13 Gerhard Fieseler Werke G m b H, Kassel, Germany
- 4 Wiener Neustaedter Flugzeugwerke, Wiener Neustadt, Austria

Aero Engines Branch

- 15 Bussing NAG Flugmotorenwerke G m b H, Brunswick, Germany
- 16 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
- 17 Bavarian Motor Works Inc, Eisenach & Durrerhof, Germany
- 18 Bayerische Motorenwerke A G (BMW) Munich, Germany
- 19 Henschel Flugmotorenwerke, Kassel, Germany

Light Metal Branch

- 20 Light Metals Industry
 - { Part I, Aluminum of Germany
 - { Part II, Magnesium
- 21 Vereinigte Deutsche Metallwerke, Hildesheim, Germany
- 22 Metallgussgesellschaft G m b H, Leipzig, Germany
- 23 Aluminiumwerk G m b H, Plant No. 2, Bitterfeld, Germany
- 24 Gebrueder Giuliani G m b H, Ludwigshafen, Germany
- 25 Luftschiffbau, Zeppelin G m b H, Friedrichshafen on Bodensee, Germany
- 26 Wieland Werke A G, Ulm, Germany
- 27 Rudolph Rautenbach Leichtmetallgiessereien, Solingen, Germany
- 28 Lippewerke Vereinigte Aluminiumwerke A G, Lunen, Germany
- 29 Vereinigte Deutsche Metallwerke, Hedderneim, Germany
- 30 Duerener Metallwerke A G, Duren Wittenau-Berlin & Waren, Germany

AREA STUDIES DIVISION

- *31 Area Studies Division Report
- 32 A Detailed Study of the Effects of Area Bombing on Hamburg
- 33 A Detailed Study of the Effects of Area Bombing on Wuppertal
- 34 A Detailed Study of the Effects of Area Bombing on Dusseldorf
- 35 A Detailed Study of the Effects of Area Bombing on Solingen
- 36 A Detailed Study of the Effects of Area Bombing on Remscheid
- 37 A Detailed Study of the Effects of Area Bombing on Darmstadt
- 38 A Detailed Study of the Effects of Area Bombing on Lubeck
- 39 A Brief Study of the Effects of Area Bombing on Berlin, Augsburg, Bochum, Leipzig, Hagen, Dortmund, Oberhausen, Schweinfurt, and Bremen

CIVILIAN DEFENSE DIVISION

- *40 Civilian Defense Division—Final Report
- 41 Cologne Field Report
- 42 Bonn Field Report
- 43 Hanover Field Report
- 44 Hamburg Field Report—Vol. I, Text; Vol. II, Exhibits
- 45 Bad Oldesloe Field Report
- 46 Augsburg Field Report
- 47 Reception Areas in Bavaria, Germany

EQUIPMENT DIVISION

Electrical Branch

- *48 German Electrical Equipment Industry Report
- 49 Brown Boveri et Cie, Mannheim-Kafertal, Germany

Optical and Precision Instrument Branch

- *50 Optical and Precision Instrument Industry Report

Abrasives Branch

- *51 The German Abrasive Industry
- 52 Mayer and Schmidt, Offenbach on Main, Germany

Anti-Friction Branch

- *53 The German Anti-Friction Bearings Industry

Machine Tools Branch

- *54 Machine Tools & Machinery as Capital Equipment
- *55 Machine Tool Industry in Germany
- 56 Herman Kolb Co., Cologne, Germany
- 57 Collet and Engelhard, Offenbach, Germany
- 58 Naxos Union, Frankfurt on Main, Germany

MILITARY ANALYSIS DIVISION

- 59 The Defeat of the German Air Force
- 60 V-Weapons (Crossbow) Campaign
- 61 Air Force Rate of Operation
- 62 Weather Factors in Combat Bombardment Operations in the European Theatre
- 63 Bombing Accuracy, USAAF Heavy and Medium Bombers in the ETO
- 64 Description of RAF Bombing
- 64a The Impact of the Allied Air Effort on German Logistics

MORALE DIVISION

- *64b The Effects of Strategic Bombing on German Morale (Vol. I and Vol. II)

Medical Branch

- *65 The Effect of Bombing on Health and Medical Care in Germany

MUNITIONS DIVISION

Heavy Industry Branch

- *66 The Coking Industry Report on Germany
- 67 Coking Plant Report No. 1, Sections A, B, C, & D
- 68 Gutehoffnungshuette, Oberhausen, Germany
- 69 Friedrich-Alfred Huette, Rheinhausen, Germany
- 70 Neunkirchen Eisenwerke A G, Neunkirchen, Germany
- 71 Reichswerke Hermann Goering A G, Hallendorf, Germany
- 72 August Thyssen Huette A G, Hamborn, Germany
- 73 Friedrich Krupp A G, Borbeck Plant, Essen, Germany
- 74 Dortmund Hoerder Huetteneverein, A G, Dortmund, Germany
- 75 Hoesch A G, Dortmund, Germany
- 76 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany

Motor Vehicles and Tanks Branch

- *77 German Motor Vehicles Industry Report

- *78 Tank Industry Report
- 79 Daimler Benz A G, Unterturkheim, Germany
- 80 Renault Motor Vehicles Plant, Billancourt, Paris
- 81 Adam Opel, Russelheim, Germany
- 82 Daimler-Benz-Gaggenau Works, Gaggenau, Germany
- 83 Maschinenfabrik Augsburg-Nurnberg, Nurnberg, Germany
- 84 Auto Union A G, Chemnitz and Zwickau, Germany
- 85 Henschel & Sohn, Kassel, Germany
- 86 Maybach Motor Works, Friedrichshafen, Germany
- 87 Voigtlander, Maschinenfabrik A G, Plauen, Germany
- 88 Volkswagenwerke, Fallersleben, Germany
- 89 Bussing NAG, Brunswick, Germany
- 90 Muehlenbau Industrie A G (Miag) Brunswick, Germany
- 91 Friedrich Krupp Grusonwerke, Magdeburg, Germany

Submarine Branch

- 92 German Submarine Industry Report
- 93 Maschinenfabrik Augsburg-Nurnberg A G, Augsburg, Germany
- 94 Blohm and Voss Shipyards, Hamburg, Germany
- 95 Deutsche Werke A. G., Kiel, Germany
- 96 Deutsche Schiff und Maschinenbau, Bremen, Germany
- 97 Friedrich Krupp Germaniawerft, Kiel, Germany
- 98 Howaldtswerke A. G., Hamburg, Germany
- 99 Submarine Assembly Shelter, Farge, Germany
- 100 Bremer Vulkan, Vegesack, Germany

Ordnance Branch

- *101 Ordnance Industry Report
- 102 Friedrich Krupp Grusonwerke A. G. Magdeburg, Germany
- 103 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany
- 104 Henschel & Sohn, Kassel, Germany
- 105 Rheinmetall-Borsig, Dusseldorf, Germany
- 106 Hermann Goering Werke, Braunschweig, Hallendorf, Germany
- 107 Hannoverische Maschinenbau, Hanover, Germany
- 108 Gusstahlfabrik Friedrich Krupp, Essen, Germany

OIL DIVISION

- *109 Oil Division, Final Report
- *110 Oil Division, Final Report, Appendix
- *111 Powder, Explosives, Special Rockets and Jet Propellants, War Gases and Smoke Acid (Ministerial Report #1)
- 112 Underground and Dispersal Plants in Greater Germany
- 113 The German Oil Industry, Ministerial Report Team 78
- 114 Ministerial Report on Chemicals

Oil Branch

- 115 Ammoniakwerke Merseburg G m b H, Leuna, Germany—2 Appendices
- 116 Braunkohle Benzin A G, Zeitz and Bohlen, Germany
- Wintershall A G, Luetzkendorf, Germany
- 117 Ludwigshafen-Opau Works of I G Farbenindustrie A G, Ludwigshafen, Germany

- 118 Ruhroel Hydrogenation Plant, Bottrop-Boy, Germany, Vol. I, Vol. II
- 119 Rhenania Ossag Mineraloelwerke A G, Harburg Refinery, Hamburg, Germany
- 120 Rhenania Ossag Mineraloelwerke A G, Grasbrook Refinery, Hamburg, Germany
- 121 Rhenania Ossag Mineraloelwerke A G, Wilhelmsburg Refinery, Hamburg, Germany
- 122 Gewerkschaft Victor, Castrop-Rauxel, Germany, Vol. I & Vol. II
- 123 Europaeische Tanklager und Transport A G, Hamburg, Germany
- 124 Ebano Asphalt Werke A G, Harburg Refinery, Hamburg, Germany
- 125 Meerbeck Rheinpreussen Synthetic Oil Plant—Vol. I & Vol. II.

Rubber Branch

- 126 Deutsche Dunlop Gummi Co., Hanau on Main, Germany
- 127 Continental Gummiwerke, Hanover, Germany
- 128 Huels Synthetic Rubber Plant
- 129 Ministerial Report on German Rubber Industry

Propellants Branch

- 130 Elektrochemischewerke, Munich, Germany
- 131 Schoenebeck Explosive Plant, Lignose Sprengstoff Werke G m b H, Bad Salzeman, Germany
- 132 Plants of Dynamit A G, Vormal, Alfred Nobel & Co, Troisdorf, Clausthal, Drummel and Duneberg, Germany
- 133 Deutsche Sprengchemie G m b H, Kraiburg, Germany

OVER-ALL ECONOMIC EFFECTS DIVISION

- 134 Over-all Economic Effects Division Report
- Gross National Product } Special papers
- Kriegsberichte } which together
- Herman Goering Works } comprise the
- Food and Agriculture } above report
- 134a Industrial Sales Output and Productivity

PHYSICAL DAMAGE DIVISION

- 134b Physical Damage Division Report (ETO)
- 135 Villacoublay Airdrome, Paris, France
- 136 Railroad Repair Yards, Malines, Belgium
- 137 Railroad Repair Yards, Louvain, Belgium
- 138 Railroad Repair Yards, Hasselt, Belgium
- 139 Railroad Repair Yards, Namur, Belgium
- 140 Submarine Pens, Brest, France
- 141 Powder Plant, Angoulême, France
- 142 Powder Plant, Bergerac, France
- 143 Coking Plants, Montigny & Liege, Belgium
- 144 Fort St. Elaise Verdun Group, Metz, France
- 145 Gnome et Rhone, Limoges, France
- 146 Michelin Tire Factory, Clermont-Ferrand, France
- 147 Gnome et Rhone Aero Engine Factory, Le Mans, France
- 148 Kugelfischer Bearing Ball Plant, Ebelsbach, Germany
- 149 Louis Breguet Aircraft Plant, Toulouse, France
- 150 S. N. C. A. S. E. Aircraft Plant, Toulouse, France
- 151 A. I. A. Aircraft Plant, Toulouse, France

- 152 V Weapons in London
- 153 City Area of Krefeld
- 154 Public Air Raid Shelters in Germany
- 155 Goldenberg Thermal Electric Power Station, Knap-sack, Germany
- 156 Brauweiler Transformer & Switching Station, Brau-weiler, Germany
- 157 Storage Depot, Nahlbollenbach, Germany
- 158 Railway and Road Bridge, Bad Munster, Germany
- 159 Railway Bridge, Eller, Germany
- 160 Gustloff-Werke Weimar, Weimar, Germany
- 161 Henschel & Sohn G m b H, Kassel, Germany
- 162 Area Survey at Pirmasens, Germany
- 163 Hanomag, Hanover, Germany
- 164 M A N Werke Augsburg, Augsburg, Germany
- 165 Friedrich Krupp A G, Essen, Germany
- 166 Erla Maschinenwerke, G m b H, Heiterblick, Germany
- 167 A T G Maschinenbau G m b H, Mockau, Germany
- 168 Erla Maschinenwerke G m b H, Mockau, Germany
- 169 Bayerische Motorenwerke, Durrerhof, Germany
- 170 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
- 171 Submarine Pens Deutsche-Werft, Hamburg, Germany
- 172 Multi-Storied Structures, Hamburg, Germany
- 173 Continental Gummiwerke, Hanover, Germany
- 174 Kassel Marshalling Yards, Kassel, Germany
- 175 Ammonia Werke, Merseburg-Leuna, Germany
- 176 Brown Boveri et Cie, Mannheim, Kafertal, Germany
- 177 Adam Opel A G, Russelsheim, Germany
- 178 Daimler-Benz A G, Unterturkheim, Germany
- 179 Valentin Submarine Assembly, Farge, Germany
- 180 Volkswaggonwerke, Fallersleben, Germany
- 181 Railway Viaduct at Bielefeld, Germany
- 182 Ship Yards Howaldtswerke, Hamburg, Germany
- 183 Blohm and Voss Shipyards, Hamburg, Germany
- 184 Daimler-Benz A G, Mannheim, Germany
- 185 Synthetic Oil Plant, Meerbeck-Hamburg, Germany
- 186 Gewerkschaft Victor, Castrop-Rauxel, Germany
- 187 Klockner Humboldt Deutz, Ulm, Germany
- 188 Ruhroel Hydrogenation Plant, Bottrop-Boy, Germany
- 189 Neunkirchen Eisenwerke A G, Neunkirchen, Germany
- 190 Railway Viaduct at Altenbecken, Germany
- 191 Railway Viaduct at Arnburg, Germany
- 192 Deurg-Nerag Refineries, Misburg, Germany
- 193 Fire Raids on German Cities
- 194 I G Farbenindustrie, Ludwigshafen, Germany, Vol. I & Vol. II
- 195 Roundhouse in Marshalling Yard, Ulm, Germany
- 196 I G Farbenindustrie, Leverkusen, Germany
- 197 Chemische-Werke, Huels, Germany
- 198 Gremberg Marshalling Yard, Gremberg, Germany
- 199 Locomotive Shops and Bridges at Hamm, Germany

TRANSPORTATION DIVISION

- *200 The Effects of Strategic Bombing on German Trans-
portation
- 201 Rail Operations Over the Brenner Pass
- 202 Effects of Bombing on Railroad Installations in
Regensburg, Nurnberg and Munich Divisions
- 203 German Locomotive Industry During the War
- 204 German Military Railroad Traffic

UTILITIES DIVISION

- *205 German Electric Utilities Industry Report
- 206 1 to 10 in Vol. I "Utilities Division Plant Reports"
- 207 11 to 20 in Vol. II "Utilities Division Plant Reports"
- 208 21 Rheinische-Westfalische Elektrizitaetswerk A G

Pacific War

OFFICE OF THE CHAIRMAN

- *1 Summary Report (Pacific War)
- *2 Japan's Struggle to End The War
- *3 The Effects of Atomic Bombs on Hiroshima and Nagasaki

CIVILIAN STUDIES

Civilian Defense Division

- 4 Field Report Covering Air Raid Protection and Allied Subjects, Tokyo, Japan
- 5 Field Report Covering Air Raid Protection and Allied Subjects, Nagasaki, Japan
- *6 Field Report Covering Air Raid Protection and Allied Subjects, Kyoto, Japan
- 7 Field Report Covering Air Raid Protection and Allied Subjects, Kobe, Japan
- 8 Field Report Covering Air Raid Protection and Allied Subjects, Osaka, Japan
- 9 Field Report Covering Air Raid Protection and Allied Subjects, Hiroshima, Japan—No. 1
- *10 Summary Report Covering Air Raid Protection and Allied Subjects in Japan
- *11 Final Report Covering Air Raid Protection and Allied Subjects in Japan

Medical Division

- *12 The Effects of Bombing on Health and Medical Services in Japan
- *13 The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki

Morale Division

- *14 The Effects of Strategic Bombing on Japanese Morale

ECONOMIC STUDIES

Aircraft Division

- *15 The Japanese Aircraft Industry
- *16 Mitsubishi Heavy Industries, Ltd.
Corporation Report No. I
(Mitsubishi Junkogyo KK)
(Airframes & Engines)
- *17 Nakajima Aircraft Company, Ltd.
Corporation Report No. II
(Nakajima Hikoki KK)
(Airframes & Engines)
- *18 Kawanishi Aircraft Company
Corporation Report No. III
(Kawanishi Kokuki Kabushiki Kaisha)
(Airframes)
- *19 Kawasaki Aircraft Industries Company, Inc.
Corporation Report No. IV
(Kawasaki Kokuki Kogyo Kabushiki Kaisha)
(Airframes & Engines)

- *20 Aichi Aircraft Company
Corporation Report No. V
(Aichi Kokuki KK)
(Airframes & Engines)
- *21 Sumitomo Metal Industries, Propeller Division
Corporation Report No. VI
(Sumitomo Kinzoku Kogyo KK, Puropera Seizosho)
(Propellers)
- *22 Hitachi Aircraft Company
Corporation Report No. VII
(Hitachi Kokuki KK)
(Airframes & Engines)
- *23 Japan International Air Industries, Ltd.
Corporation Report No. VIII
(Nippon Kokusai Koku Kogyo KK)
(Airframes)
- *24 Japan Musical Instrument Manufacturing Company
Corporation Report No. IX
(Nippon Gakki Seizo KK)
(Propellers)
- *25 Tachikawa Aircraft Company
Corporation Report No. X
(Tachikawa Hikoki KK)
(Airframes)
- *26 Fuji Airplane Company
Corporation Report No. XI
(Fuji Hikoki KK)
(Airframes)
- *27 Showa Airplane Company
Corporation Report No. XII
(Showa Hikoki Kogyo KK)
(Airframes)
- *28 Ishikawajima Aircraft Industries Company, Ltd.
Corporation Report No. XIII
(Ishikawajima Koku Kogyo Kabushiki Kaisha)
(Engines)
- *29 Nippon Airplane Company
Corporation Report No. XIV
(Nippon Hikoki KK)
(Airframes)
- *30 Kyushu Airplane Company
Corporation Report No. XV
(Kyushu Hikoki KK)
(Airframes)
- *31 Shoda Engineering Company
Corporation Report No. XVI
(Shoda Seisakujo)
(Components)
- *32 Mitaka Aircraft Industries
Corporation Report No. XVII
(Mitaka Koku Kogyo Kabushiki Kaisha)
(Components)
- *33 Nissan Automobile Company
Corporation Report No. XVIII
(Nissan Jidosha KK)
(Engines)
- *34 Army Air Arsenal & Navy Air Depots
Corporation Report No. XIX
(Airframes and Engines)
- *35 Underground Production of Japanese Aircraft
Report No. XX

Basic Materials Division

- *36 Coal and Metals in Japan's War Economy

Capital Goods, Equipment and Construction Division

- *37 The Japanese Construction Industry
- *38 Japanese Electrical Equipment
- *39 The Japanese Machine Building Industry

Electric Power Division

- *40 The Electric Power Industry of Japan
- *41 The Electric Power Industry of Japan (Plant Reports)

Manpower, Food and Civilian Supplies Division

- *42 The Japanese Wartime Standard of Living and Utilization of Manpower

Military Supplies Division

- *43 Japanese War Production Industries
- *44 Japanese Naval Ordnance
- 45 Japanese Army Ordnance
- *46 Japanese Naval Shipbuilding
- *47 Japanese Motor Vehicle Industry
- *48 Japanese Merchant Shipbuilding

Oil and Chemical Division

- 49 Chemicals in Japan's War
- 50 Chemicals in Japan's War—Appendix
- 51 Oil in Japan's War
- 52 Oil in Japan's War—Appendix

Over-all Economic Effects Division

- *53 The Effects of Strategic Bombing on Japan's War Economy (Including Appendix A: U. S. Economic Intelligence on Japan—Analysis and Comparison; Appendix B: Gross National Product on Japan and Its Components; Appendix C: Statistical Sources).

Transportation Division

- *54 The War Against Japanese Transportation, 1941–1945

Urban Areas Division

- *55 Effects of Air Attack on Japanese Urban Economy (Summary Report)
- *56 Effects of Air Attack on Urban Complex Tokyo-Kawasaki-Yokohama
- *57 Effects of Air Attack on the City of Nagoya
- *58 Effects of Air Attack on Osaka-Kobe-Kyoto
- 59 Effects of Air Attack on the City of Nagasaki
- 60 Effects of Air Attack on the City of Hiroshima

MILITARY STUDIES

Military Analysis Division

- 61 Air Forces Allied with the United States in the War Against Japan
- 62 Japanese Air Power
- 63 Japanese Air Weapons and Tactics
- 64 The Effect of Air Action on Japanese Ground Army Logistics
- 65 Employment of Forces Under the Southwest Pacific Command
- 66 The Strategic Air Operations of Very Heavy Bom-

bardment in the War Against Japan (Twentieth Air Force)

- 67 Air Operations in China, Burma, India—World War II
- 68 The Air Transport Command in the War Against Japan
- 69 The Thirteenth Air Force in the War Against Japan
- 70 The Seventh and Eleventh Air Forces in the War Against Japan
- 71 The Fifth Air Force in the War Against Japan

Naval Analysis Division

- *72 The Interrogations of Japanese Officials (Vols. I and II)
- *73 Campaigns of the Pacific War
- *74 The Reduction of Wake Island
- *75 The Allied Campaign Against Rabaul
- 76 The American Campaign Against Wotje, Maloelap, Mille, and Jaluit (Vols. I, II and III)
- *77 The Reduction of Truk
- 78 The Offensive Mine Laying Campaign Against Japan
- 79 Report of Ships Bombardment Survey Party—Foreword, Introduction, Conclusions, and General Summary
- 80 Report of Ships Bombardment Survey Party (Enclosure A), Kamaishi Area
- 81 Report of Ships Bombardment Survey Party (Enclosure B), Hamamatsu Area
- 82 Report of Ships Bombardment Survey Party (Enclosure C), Hitachi Area
- 83 Report of Ships Bombardment Survey Party (Enclosure D), Hakodate Area
- 84 Report of Ships Bombardment Survey Party (Enclosure E), Muroran Area
- 85 Report of Ships Bombardment Survey Party (Enclosure F), Shimizu Area
- 86 Report of Ships Bombardment Survey Party (Enclosures G and H), Shionomi-Saki and Nojima-Saki Areas
- 87 Report of Ships Bombardment Survey Party (Enclosure I), Comments and Data on Effectiveness of Ammunition
- 88 Report of Ships Bombardment Survey Party (Enclosure J), Comments and Data on Accuracy of Firing
- 89 Reports of Ships Bombardment Survey Party (Enclosure K), Effects of Surface Bombardments on Japanese War Potential

Physical Damage Division

- 90 Effect of the Incendiary Bomb Attacks on Japan (a Report on Eight Cities)
- 91 The Effects of the Ten Thousand Pound Bomb on Japanese Targets (a Report on Nine Incidents)
- 92 Effects of the Atomic Bomb on Hiroshima, Japan
- 93 Effects of the Atomic Bomb on Nagasaki, Japan
- 94 Effects of the Four Thousand Pound Bomb on Japanese Targets (a Report on Five Incidents)
- 95 Effects of Two Thousand, One Thousand, and Five Hundred Pound Bombs on Japanese Targets (a Report on Eight Incidents)
- 96 A Report on Physical Damage in Japan (Summary Report)

G-2 Division

- 97 Japanese Military and Naval Intelligence
- 98 Evaluation of Photographic Intelligence in the Japanese Homeland, Part I, *Comprehensive Report*
- 99 Evaluation of Photographic Intelligence in the Japanese Homeland, Part II, *Airfields*
- 100 Evaluation of Photographic Intelligence in the Japanese Homeland, Part III, *Computed Bomb Plotting*
- 101 Evaluation of Photographic Intelligence in the Japanese Homeland, Part IV, *Urban Area Analysis*
- 102 Evaluation of Photographic Intelligence in the Japanese Homeland, Part V, *Camouflage*
- 103 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VI, *Shipping*
- 104 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VII, *Electronics*
- 105 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VIII, *Beach Intelligence*
- *106 Evaluation of Photographic Intelligence in the Japanese Homeland, Part IX, *Artillery*
- *107 Evaluation of Photographic Intelligence in the Japanese Homeland, Part X, *Roads and Railroads*
- 108 Evaluation of Photographic Intelligence in the Japanese Homeland, Part XI, *Industrial Analysis*

☆ U. S. GOVERNMENT PRINTING OFFICE: 1947—736925

24

BOSTON PUBLIC LIBRARY



3 9999 06313 355 5

